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Economic growth and regional inequality in Ecuador

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BCE	Central Bank of Ecuador
GVA	Gross value-added
GDP	Gross domestic product
INEC	National Institute of Statistics and Census
SENPLADES	National Secretariat of Planification and Development
SIISE	Integrated System of Social Indicators of Ecuador

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Finally, the present research paper is dedicated to the memory of my father. All the struggles are worth if they are meant to become a better person.

Abstract

The objective of the present research paper is to analyse the relationship between economic growth and regional inequality in Ecuador. For this, it relies on the use of regional gross value-added estimates for the provinces of Ecuador in the period 2007-2016. The analysis makes use of a parametric and a non-parametric approach to determine if there has been a reduction of the inequality among provinces, along with the causes of unequal regional growth.

The results indicate that regional inequality has decreased in the period of analysis, mainly driven by the reduction in the growth rates of the national economy. The analysis also suggests that there exists a process of absolute and conditional convergence since poor provinces are growing faster than the rich ones. Besides, the outcomes of the non-parametric approach indicate that the dispersion of the product of the provinces has reduced, and the gap between poor and rich provinces have decreased between the period of analysis.

Relevance to Development Studies

The analysis of the regional inequality is important because it is necessary to determine the causes that are associated with the growth or the stagnation of the economic activity at a regional level. In this sense, by accounting for the factors that cause these differences, it is possible to formulate adequate policies that boost the development at a regional level.

From a theoretical perspective, despite the present research uses a neoclassical framework to analyse the determinants of the economic growth at a regional level, it considers other approaches that have been recently developed in the literature to address this phenomenon. The use of these novel approaches, such as the New Economic Geography or the New Institutional Economy, aim to extend the analysis beyond the traditional theories of economic growth.

From a methodological perspective, this paper adds to the literature a combination of approaches that have not been properly accounted in previous research. As a result, it provides a more comprehensive vision of the problematic of regional inequality.

Keywords

Economic growth, regional inequality, convergence, regional development.

Chapter 1 Introduction

One of the goals of the National Development Plan for the period 2007-2010 was to promote equality, cohesion and social and regional integration. (SENPLADES 2007:81). In this sense, one of the policies was the promotion of an equilibrated and integrated local development through several strategies such as the creation of national cohesion funds, the support of the projects of public investment at a local level and the development of intermediate cities (SENPLADES 2007:92). Giving continuity to this proposal, the National Development Plan for the period 2013-2017 establishes a National Territorial Strategy to promote an equal development of the regions through the improvement of public infrastructure, the organization of human settlements, the productive transformation and the closure of gaps in terms of living conditions of the population (SENPLADES 2014:88)

In this sense, the main objective of the present document is to analyse if the process of economic growth has contributed to the reduction of the gaps among provinces in terms of their output, measured through the gross value-added. This will be accomplished using parametric and non-parametric methods to examine the evolution of the regional inequality and the determinants of growth at a regional level.

The present document is organized as follows. Chapter two contains a summary of the relevant studies associated with the topic and the contribution of this paper to the literature. Chapter three contains the methodology, the empirical model and the data used in the analysis, along with its description. Chapter four presents the results of the convergence analysis, both in absolute and conditional terms. Chapter five extends the analysis of convergence and regional inequality by the analysis of the modality of the gross value-added distribution. Finally, chapter six presents the conclusions of the research and the list of references.

1. 1 Background analysis

Ecuador is a country located in Latin America. It is composed by 24 provinces, which are divided in four natural regions: Coast, Highlands, Amazon and Galápagos islands. Figure 1.1 provides an overview of the country and its political division.

Along its history, Ecuador has been characterized by the concentration of its economic activity on the three historical cities on which the country was created: Quito, Guayaquil and Cuenca, which are the capital cities of the provinces of Pichincha, Guayas and Azuay, respectively. The economy of the central and the northern parts of the country was sustained on the rents of the agricultural production and the exploitation of indigenous labour. Meanwhile, in the coastal regions, the economic model was based on the production and the exports of agricultural goods, being cocoa the most important one (Acosta 2006:29). Finally, the amazon region was not an important actor since the beginning of oil-exploitation activities in the decade of 1970 (Acosta 2006:119).

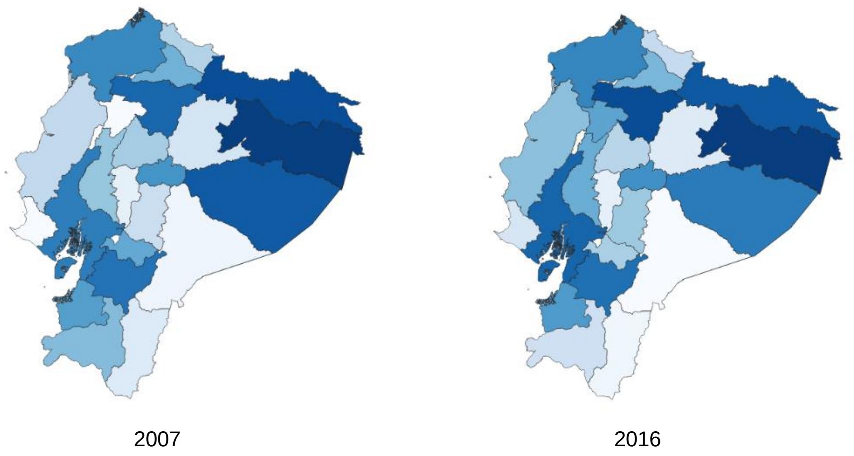
Since this point, the productive structure of the Ecuadorian economy has not suffered important changes since its creation in 1830. On the contrary, it has been characterized by the transition between different modalities of capital accumulation such as the initial exports of primary goods, an incipient attempt of industrialization promoted by the discovery and the oil exports and a final transition to a modern exploitation and exports of agricultural goods (Acosta 2006:16). This process has been accompanied by the struggle of the political actors of the three historical regions of the country (Acosta 2006:27).

Figure 1.1 Map of the provinces and regions of Ecuador

Source: forosecuador.ec (n.d.)

To put these ideas in context, the share of the per capita GVA is displayed in Figure 1.2. The provinces that hold the largest share of the total per capita GVA are the ones located in the Amazon region, being Orellana the one with the largest amount: USD 33,038.87 Thousands; which is seven times higher than the mean Per capita GVA of 2007. Along with this, its two neighbouring provinces, also present the highest amount of per capita GVA of the period due to the influence of the oil activities, which are predominant in this region. In 2016 it is possible to see a similar phenomenon with Orellana as the province with the highest GVA per capita, but with an amount of USD 12,464.61 Thousands, which is only 3.5 times above the mean value of 2016. However, the map also indicates that the province of Pichincha, where the capital is located, holds the second position while Guayas and Azuay hold the fourth and fifth position, respectively.

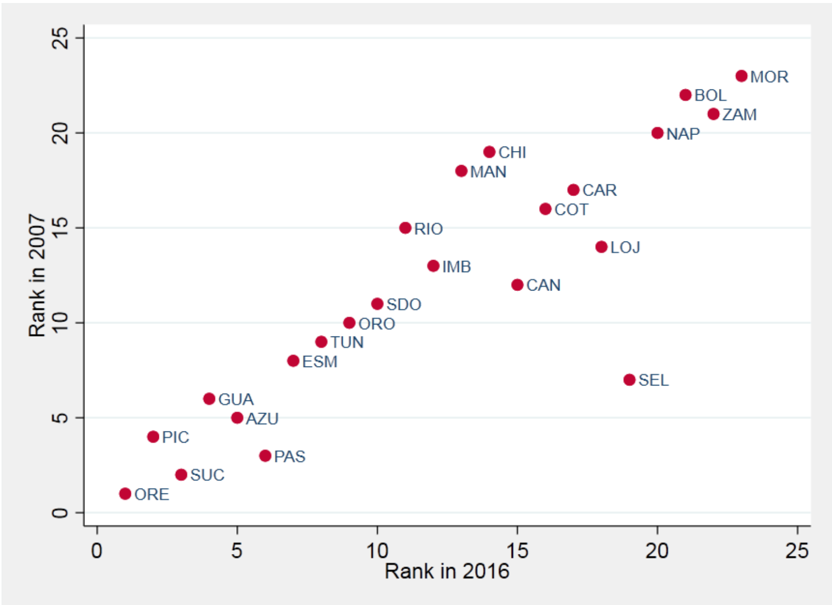
Figure 1.2 Distribution of the per capita GVA among provinces (2007, 2016)



Source: Author's elaboration

By analysing the maps, it is possible to see that the relative position of every province has not changed during the period of analysis. In fact, by ranking the provinces in terms of per capita GVA (Figure 1.3), the relative position of each one has remained similar.

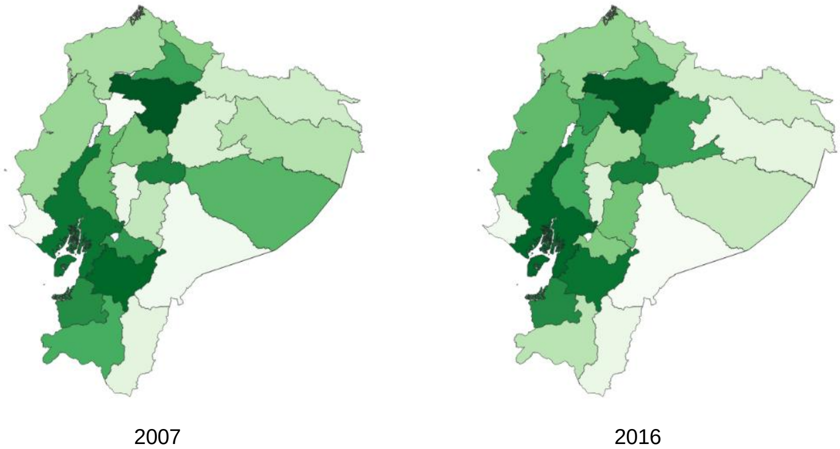
Figure 1.3 Ranking of provinces in terms of per capita GVA



Source: Author's elaboration

Nevertheless, it is important to consider that the influence of the oil rents provide an incomplete vision of the real sector of the Ecuadorian economy. In this sense, Figure 1.4 presents the distribution of the per capita GVA discounting the participation of oil-related activities. In these maps, it is possible to see that the provinces of Pichincha, Guayas and Azuay remain as the historical places where the economic activity is located. In 2007, the province that holds the larger per capita GVA is Pichincha, with a value of USD 4,946.24 Thousands, in contrast with the value of Morona Santiago, the poorest one, with a per capita GVA of USD 1,363.72 Thousands. Despite being the largest amount, it only represents 1.9 times the mean value of the year, in contrast with the total GVA per capita. In 2016, the situation remains similar but the per capita GVA of the wealthiest province, Pichincha, represents 2.3 times the mean value of the year. It is important to note that the following provinces that hold a high GVA per capita, Tungurahua and El Oro and Santo Domingo, are located close to one of these economic centres. In contrast, the provinces located in the Amazon do not display high levels of non-oil GVA and this situation remains similar along the period of analysis.

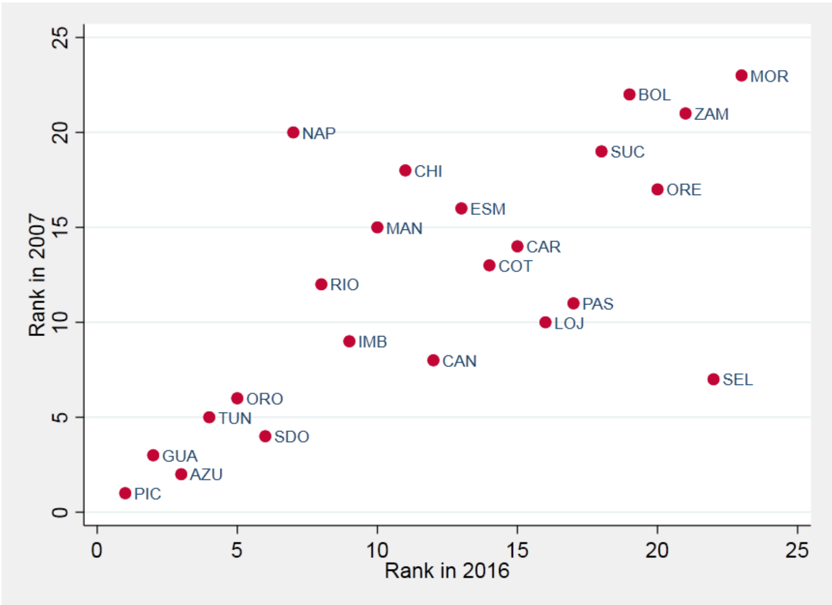
Figure 1.4 Distribution of the non-oil per capita GVA among provinces (2007, 2016)



Source: Author's elaboration

In addition, by classifying the provinces by ranks (Figure 1.5), there is more mobility between provinces, especially those located in the middle ranks. Nevertheless, there are provinces such as Morona Santiago, Zamora and Bolívar (MOR, ZAM, BOL, respectively) which are stagnated in the lower parts of the distribution for both total and non-oil per capita GVA.

Figure 1.5 Ranking of provinces in terms of non-oil per capita GVA



Source: Author's elaboration

Chapter 2 Perspectives on regional inequality and economic growth

2.1 Regional inequality

Most of the literature related to the analysis of regional inequality has been linked to the hypothesis presented by Kuznets (1955), where he proposes an inverted U relationship between economic growth and income inequality, caused by the transition from farm-based economies to industrial economies (Lessmann 2014:35). In this sense, the seminal study of Williamson (1965) empirically tests the Kuznets hypothesis for regions using data between the 19th and 20th century. His results confirm the hypothesis for countries like Italy, Brazil, United States, Canada, Germany, Sweden and France, which show the same relationship between GDP growth and regional inequality. These countries show a divergence in early stages of development and regional convergence among their regions in their latter stages of development. However, the hypothesis does not hold for developing countries like India, Indonesia and several Latin American countries, also included in the study. Lessmann (2014) continues the analysis of the existence of a Kuznets curve by analyzing a set of 56 countries in the period 1980-2009. The results are mixed because they indicate the existence of a bell-shaped relationship between economic growth and spatial inequality. However, by considering a structural shift with a higher share of manufacturing activities rather than agricultural ones, spatial inequality increases as the participation of the latter sector decreases.

Barrios and Strobl (2009) perform a similar analysis for a panel of 15 European countries in the period 1975-2000, using a non-parametric approach to identify the relationship between economic growth and regional inequality. Their results indicate that the behavior of the inequality in relation to the GDP per capita followed an inverted U relationship. Equally important is that regional inequality do not tend to increase in countries with low levels of initial GDP that face a process of structural change and rapid growth, in comparison with wealthier countries that experience similar processes.

In the same sense, Ezcurra and Rapún (2006) analyze the relationship between economic development and regional inequality among 14 European countries in the period 1980-2002 to contrast the Kuznets hypothesis and the process of national development. The results indicate a process of divergence once a certain level of economic development is achieved. However, in contrast to the results by Amos (1988), there is a decrease and a posterior stabilization of the inequality after a certain level of GDP per capita has been achieved. Their results are robust to the inclusion of additional explanatory variables such as productive specialization, population, capital stocks per worker, among others.

At a country level, Amos (1988) examines regional inequality among U.S. counties and states between 1950 and 1983 to validate the Kuznets hypothesis at latter stages of regional development. The most important finding is that regional inequality does not remain stable after a process of national development. In fact, regional inequality increases after the inverted-U shaped pattern is completed. A proof of this is that in 1950, wealthier states, in terms of GDP per capita, showed high levels of intra-regional inequality. He suggests that the changes that drive this process are the increase in suburbanization and the transition to a service-based economy. Because of these results, he suggests that the regional inequality shows an increase-decrease-increase pattern rather than the inverted-U pattern presented by Kuznets and Williamson.

Combes et al. (2011), analyzes the evolution and the determinants of spatial inequality among departments in France, for a period between 1860 and 2000. In the analysis, the find that the evolution of the inequality among French regions follow an inverted u shape, characterized by an increase in inequality in the period 1860-1930 and a reduction between 1930-2000. The driving force behind the reduction of the spatial inequality was a decrease in the concentration of industries like manufacture and service. Also, is decrease can be explained by a sustained reduction in the transportation costs along the period of analysis. In line with this, Tirado et al. (2011) revise the long-term evolution of the regional inequality across Spanish provinces, in terms of GDP per capita, for the period between 1860-2010. Their results also confirm the Kuznets hypothesis, finding that the evolution of the inequality follows an inverted u shape. However, this reduction has been followed by the creation of two groups of provinces: rich and poor ones. Although the differences between both groups have diminished, their relative position has not changed, and poor provinces have remained in the same state, showing low mobility among income classes.

2.2 Economic growth and convergence

In terms of convergence, Barro et al. (1991) examines the economic growth and dispersion of per capita income and gross state product across U.S. states in the period between 1880 and 1988, separated in nine subperiods. Results show beta convergence among states, with a speed of convergence of 2% per year. The income and product per capita of poor states grow faster in poor states but with a low rate of convergence. The southern states, which had lower per capita income at the beginning of the period show positive growth rates, indicating convergence. In terms of regional convergence (north, south, east, west), they also show convergence. The feature of the analysis is the inclusion of fixed effects like regional dummies and measures of regional composition to control for economic disturbances that can underestimate the results of the estimators and thus, the rate of convergence. In terms of sigma convergence, the dispersion of the per capita income reduces in the period of analysis, interrupted only by periods of agricultural and oil shocks. Another feature of the analysis is the behaviour between aggregate product and productivity in eight economic sectors. In terms of GSP per worker, divided in non-agricultural sectors (mining, construction, manufacturing, transportation, wholesale and retail trade, finance, insurance, real estate services and government), there is a decrease in the share of manufacture and agriculture in favour of finance, insurance and real estate. This shows a convergence in terms of productivity among sectors, expressed by an adjustment in the labour productivity for each one.

Gennaioli et al. (2014) analyze growth and inequality for a sample of 1528 regions from 83 countries with unbalanced panel data, ranging from 1950 to 2010. Their findings show that regional convergence is faster in richer countries, and these group have less regional inequality. Also, within-country regional inequality explains almost 12% of total world income inequality. Emerging economies like India, China and Chile present regional divergence. In terms of the factors that determine regional growth rates, the most important are geography and education. In the first case, latitude, inverse distance to coast, natural resource endowments and population density have an influence over growth rates of every region. However, by adding regional fixed effects, many of these results become statistically insignificant. Also, regions that include a national capital grow 1% faster. In terms of education, raising years of education by 5 years increase the annual growth rate between 0.85% and 2.8%, depending on the specification.

In Latin America, Azzoni (2001) analyzes the evolution of regional inequality in Brazin in the period 1939-1995 using GDP estimates for each region. The results indicate absolute convergence among regions, with variations in several stages of development. However, there are no concluding outcomes about the Kuznets relationship but an increasing internal inequality within poorer regions and the reverse phenomena in rich regions, even though poor regions are catching up the latter ones.

For Mexico, Rodríguez-Oreggia (2005) performs a research about the regional disparities and the determinants of growth in this country for the period between 1970 and 2000 using regional GDP data. His findings indicate that there has been a process of economic divergence, associated with a period of liberalization and increasing trade. As a result, differences among states located in the center and the south increase, while northern states converge. However, at a national level, the results indicate the existence of sigma convergence due to the reduction in the dispersion of the per capita GDP along the period of analysis

For Ecuador, Ramón-Mendieta et al. (2013) study the regional inequality among provinces in the period between 1994 and 2011. The results of their analysis show that there is absolute convergence among regions. In terms of the dispersion of the income per capita, there is a reduction in the differences between rich and poor provinces. Also, they account for spatial autocorrelation, which indicates that there is no dependence between the growth of the neighboring regions. However, their analysis lacks control variables and fixed effects to estimate the rate of convergence, and they do not rely on the use of inequality indices to explain the behavior of regional inequality.

2.3 Contribution to the literature

From the literature review, it is possible to see two major branches in the analysis of the relationship between economic growth and regional inequality. The first one, based on the seminal studies by Kuznets (1955) and Williamson (1965), is focused on the testing of the Kuznets hypothesis and establishing a long-term relationship between the growth and the inequality among regions. The second branch, based on seminal studies by Baumol (1986), Abramovitz (1986) and Barro (1991), is concerned in the process of poor regions catching up with the rich ones. While the first line of research focuses on the use of inequality indices and long-term data to analysis the relationship, the second one relies on the neoclassical growth model to test if poor provinces can catch up rich ones in a certain span.

Despite the amount of literature developed around each approach, they are not exempt of critiques. For instance, the first approach heavily depends of the use of the weighted coefficient of variation to account for the evolution of regional inequality. However, Gluschenko (2017) points out that this index is a fallacy and it does not measure regional inequality but a different phenomenon. In the case of the convergence analysis, Quah (1996a) criticizes this approach by mentioning that economic growth is not the only mechanism to reach convergence and the use of regressions do not provide insights about the behaviour of the income distribution. In this sense, he proposes a non-parametric approach through the analysis of the distribution to study the differences between rich and poor economies and to prove if the gap between rich and poor is reducing.

With these antecedents, the present research paper aims to contribute to the literature with the analysis of the relationship between economic growth and regional inequality through a parametric and a non-parametric approach. In a first stage, the parametric approach based on regression analysis is used to determine if poor provinces are growing faster than the rich ones, leading to a process of convergence. In addition, since economic growth involves a series of geographic, demographic, structural and institutional changes (Acemoglu 2012:546), the aim of the present research is to account for these factors and its relevance in the process of growth. The second stage comprehends a non-parametric approach, in which the dynamics of the distribution of the wealth among provinces is analysed. With this framework, it is possible to asses if the gap between poor and rich provinces is widening or not and obtain a measure for these differences.

By using this combined approach, this research looks forward to cover the majority of the topics that comprehends the analysis of the relationship between economic growth and regional inequality, and provide sound conclusions to the debate of this problematic.

Chapter 3 Methodology

The present section corresponds to the definition of the research questions and the identification strategy to address the problematic. It also includes a description of the data and summary statistics of the analysed variables.

The initial part of the methodology consists in the definition of the research questions of the present research paper. In this sense, the proposed main research question and the sub research questions are the following ones, respectively:

- What is the relationship between economic growth and regional inequality in Ecuador?
- Is there a process of convergence or divergence between rich and poor provinces?
- Which are the factors that drive a possible convergence among the provinces?
- What is the behaviour of the distribution of wealth among the provinces?

3.1 Identification strategy

To address the research questions of the paper, I follow the present identification strategy, which is divided in three steps. The first step involves the analysis of the evolution of regional inequality using measures of interpersonal inequality such as Gini and Theil (1) indices. The indices are defined as (Ezcurra and Rapún 2006:365):

$$Gini = \frac{\sum_{i=1}^{n_c} \sum_{j=1}^{n_c} p_{it} p_{jt} |x_{it} - x_{jt}|}{2\mu_{ct}}$$

$$Theil\ (1)_{ct} = \sum_{i=1}^{n_c} p_{it} \left(\frac{x_{it}}{\mu_{ct}}\right) log \left(\frac{x_{it}}{\mu_{ct}}\right)$$

The second step consist in the analysis of convergence using a neoclassical framework established by Barro and Sala-i-Martin (2004). The neoclassical growth model, as proposed by Barro and Sala-i-Martin (2004), has the property of predicting economic convergence among regions. In this sense, there are two kinds of concepts of convergence that has been developed in the literature and will be applied in the present research: β convergence and σ convergence. The first one involves poor economies, or provinces in this case, growing faster than rich ones, reaching the levels of income of the latter ones (Barro and Sala-i-Martin 2004:462). On the other side, σ convergence is defined by the reduction of the dispersion of the standard deviation of the logarithm of the per capita income (Barro and Sala-i-Martin 2004:462).

It is possible to obtain an estimate of beta convergence by using a growth equation from the neoclassical growth model, defined by (Barro and Sala-i-Martin 2004:467):

$$\left(\frac{1}{T}\right).\log\left(\frac{y_{iT}}{y_{i0}}\right) = a - \left[\frac{1-e^{-\beta T}}{T}\right].\log(y_{i0}) + w_{i0,T}$$

where y_{iT} is the output in the period T, y_{i0} is the initial output and $w_{i0,T}$ represents the effects of the error terms in the interval of time between 0 and T. Also, from this equation it is possible to estimate the annual speed of convergence and the half-life, which measures the necessary time to eliminate half of the initial output inequalities (Simionescu 2014:169):

$$Speed\ of\ convergence\ (b) = -\frac{\ln(1+\beta)}{T}$$

$$Half-life\ (\tau) = \frac{\ln(2)}{\beta}$$

Since the estimates of this equation may be biased due to the presence of omitted variables, Barro (1991) proposes the inclusion of additional explanatory variables in the regression to control for disturbances that could alter the results. Because of this: the following model is proposed to address any possible source of bias:

$$Grate_{it} = \alpha + \beta_1 \ln(GVApc)_{i0} + \beta_2 Z_{it} + \varepsilon_{it},$$

For province *i* in the year *t,* where:

$Grate$ is the average growth rate of the per capita GVA,

$GVApc$ is the the initial per capita GVA,

Z_{it} is a vector of variables that determine economic growth at a province level. They are divided in three groups: geographic and demographic, structural and institutional determinants. The list of the variables is presented in Table 3.1. Furthermore, since regional growth rate is affected by the growth of the neighbouring provinces, an analysis of the spatial autocorrelation will be included to account for this phenomenon.

The third step is a complement to the analysis of convergence since this approach does not bring information about the dynamics of the income distribution and how it evolves over time (Magrini 2004:2743). In this sense, the dispersion of the gross value-added among regions (σ convergence) and the kernels densities will be used to analyse the distribution of the gross value-added among provinces and to evaluate if the difference between rich and poor provinces have changed during the period of analysis.

3.2 Data and descriptive statistics

For the analysis of the regional inequality, per capita Gross Value-Added (GVA) will be used as our main variable if interest, obtained from the National Accounts from the Central Bank of Ecuador (2018). For the Ecuadorian case, it constitutes a good indicator of the economic activity at the province level compared to the GDP. GVA will be used as a proxy because, like GDP, economies at the same income level have similar attributes such as education levels, knowledge accumulation, infrastructure and institutional quality (Iammarino et al. 2018:26). In this sense, differences in GDP, or GVA as the present case, may be caused by an unequal distribution of these characteristics. Another advantage of the GVA is the fact that it measures actual production of goods and services, discounting the influence of taxes or subsidies, which are accounted in the GDP. In the present analysis, another strength lies on the possibility of discarding the influence of the oil activities on the total GVA. By discounting activities related to oil production and refining, it is possible to obtain a different picture of the economic structure of each province. With this background, a non-oil per capita GVA is incorporated in the analysis.

Since measurement error is a main concern in the convergence literature (Durlauf et al. 2005:590) there is one possible source of bias in this variable. Considering that GVA is divided by population to obtain per capita values, the accuracy of the latter variable must be pointed out. The source of the data is the population forecasts based on the Population Census of 2010 (INEC 2010). When comparing the forecasts against the survey estimates, the former ones tend to be underestimated. In this sense, the per capita GVA might be overestimated from 2014 and on, because the information of labour surveys in Ecuador provide a higher population estimate. However, the use of the labour surveys to obtain population estimates is discarded because they do not provide accurate measures at a province level.

As mentioned before, since economic growth involves a series of geographic, demographic, structural and institutional changes (Acemoglu 2012:546), the variables used in the present analysis are listed according to this classification. First, in terms of the geographic and demographic determinants of growth, the proportion of urban population was calculated using data from labor surveys (INEC 2018a), despite the previous indication. The justification of this choice is that this variable is not subject to changes in the short-run. According to the literature, this variable has a positive influence on the growth rate (Hassan 2004:129, Gennaioli 2014:300). The second variable of this group is the area of the province, which was calculated using GIS and maps provided by the National Institute of Statistics and Census from Ecuador (2018b). A positive effect on the growth rates is expected since the area of a province may be related to a natural resource advantage (Hassan 2004:2). Finally, the natural region dummy was calculated according to the natural region where each province is located: Coast, Highlands or Amazon (Figure 1.1). The islands were discarded from the analysis due to their geographic location, which may bias the results.

The group of the structural variables is composed by the share of the agriculture, manufacture and oil activities on the total GVA (BCE 2018). They are used to determine how does the economic structure of a province is related to high or low growth rates. Also, a variable that captures the influence of the growth of the neighbouring provinces was calculated to control for potential and spatial spurious correlations (Papyrakis and Raveh 2014:183)

In the group of the institutional variables, the total income of the province consists in the sum of the total revenues of the Municipalities and the Provincial governments of every province. This information was obtained from the Ecuadorean Development Bank (2018). The second variable is an ethnical fractionalization index, which measures the probability that two individuals from a region belong to different ethnolinguistic groups (Easterly and Levine 1997). This variable is important because ethnical fractionalization and institutional quality define convergence clubs (as cited in Durlauf et al. 2005:620).

Also, to account for violence levels, the murder rate per 100.000 inhabitantss is used, obtained from the Ministry of Internal Affairs (2018). It is expected to have a negative influence on growth due to the material costs in human lives and the opportunity costs of relocating resources to security (Borguignon 2004:17).

Since there are no measures of infrastructure at a local level, the mortality rate in transit accidents is used as a proxy to account for the development of physical infrastructure, like roads. According to Egert et al. (2009), for OECD countries, infrastructure investment has a positive effect on growth due to economies of scale, network externalities and competition enhancing effects. Because of this, a negative relationship with growth is expected. This variable was obtained from the National Institute of Statistics and Census (2018c).

Finally, the variable that measures human capital (sharedegree) indicates the share of the population over 25 years that have a higher education degree. This variable presents information only for two years: 2007 and 2011. The data from 2007 was imputed from the Life Conditions Survey performed in 2006 (INEC 2006). For 2011, the data comes from the Population and Housing Census (INEC 2010).

The list of variables that are going to be used in the analysis is presented in Table 3.1. They were grouped according to the type of determinant that they represent.

Table 3.1 Variable list

Categories	Variable	Code
Dependent	Per capita GVA (USD Thousands 2007)	gva
	Non-oil per capita GVA (USD Thousands 2007)	gva2
Geographic - demographic	Proportion of urban population	urban
	Area (km2)	area
	Natural region (dummy, 1: coast; 2: highlands; 3: amazon)	natregion
Structural	Share of agriculture in GVA	agrishare
	Share of manufacture in GVA	manushare
	Share of oil activities in GVA	oilshare
	Influence from neighboring provinces	ninfluence
Institutional	Total income of the province (USD Thousands 2007)	incomer
	Ethnical fractionalization index	fractio
	Murder rate (murdering per 100.000 inhabitants)	murder
	Mortality rate in transit accidents (mortality per 100.000 inhabitants)	deathroads
	Share of population with higher education degree (above 25 years)	sharedegree

Source: Author's elaboration

The descriptive statistics for each variable are presented in Table 3.2. From this, it is possible to see that the gross value-added (gva) presents a higher dispersion in contrast with the non-oil gross value-added (gva2). Also, this variable does not have complete observations because two new provinces, Santa Elena and Santo Domingo, were created in 2007. To overcome this, the values of the GVA from 2008 were imputed in 2007 to perform the analysis of absolute convergence. However, in the conditional convergence analysis the are discarded since there is not additional information for these provinces in 2007.

Among the geographical variables, the range between small and large provinces is determined by the extension of the provinces in the Amazon region, which are the largest ones of the country (Pastaza, Morona Santiago and Orellana). In terms of urban population, the provinces of Guayaquil and Pichincha present the largest proportion of citizens living in urban areas (85% and 84% respectively). On the contrary, provinces such as Bolívar, Orellana and Napo present the lowest proportion, being 25% in all the cases.

The structural determinants show low dispersion, except for the share of the oil activities in the total GVA. This is caused by the provinces located in the Amazon region that are heavily dependent of this activity. For example, in the province of Orellana, the mean share of the oil activities during the period od analysis is 93%. The province of Sucumbíos ranks second with an average share of 78% and third is Pastaza, with a share of 66%. In contrast, the provinces that hold the largest average share of manufacturing activities are Guayas (20%), Pichincha (19%), and Azuay (17%), the traditional centres of economic activity of the country.

The variable that captures the influence from neighbouring provinces (ninfluence) also presents an incomplete series because is calculated from the growth rates, so its available from 2008 onwards. In the case of the murder rates, the series is also incomplete because this variable is available since 2011.

In the case of the institutional determinants, they do not have complete information to perform panel data regressions but cross section analysis. For example, murder rates are available from 2011 onwards, and the share of population with higher education is available only for 2007 and 2011. By analysing the statistics, it is possible to see that the murder rate is one of the variables that also present a higher dispersion. This is caused by the murder rates of the provinces of Esmeraldas and Sucumbíos, which have mean rates of 27.94% and 26.42%, respectively. The human capital variable (sharedegree) also presents a high dispersion. This result is influenced by the province of Pichincha, which holds the largest average share of population with degree during the period of analysis, with a value of 21.69%. The province that holds the least amount is Santa Elena, with 8.25%.

Table 3.2 Descriptive statistics

Variable	Code	Obs	Mean	Std. Dev.	Min	Max
Gross value-added per capita (USD Thousands, 2007 prices)	gva	228	4,525.08	6,734.51	1,363.72	42,802.00
Gross value-added per capita (excl. Oil activities, USD Thousands, 2007 prices)	gva2	228	2,589.01	884.67	1,363.72	6,318.01
Area (km2)	area	230	10,881.98	7,485.87	3,188.01	29,893.54
Proportion of urban population	urban	230	0.51	0.19	0.13	0.97
Natural region (dummy)	natregion	230	1.96	0.75	1.00	3.00
Share of agriculture in total GVA	agrishare	228	0.13	0.10	0.01	0.43
Share of manufacture in total GVA	manushare	228	0.07	0.06	0.00	0.23
Share of oil activities in total GVA	oilshare	228	0.12	0.27	0.00	0.96
Influence from neighboring provinces	ninfluence	207	0.00	0.00	-0.01	0.02
Total income of the province (USD Thousands, 2007 prices)	income	228	211.57	248.13	29.41	1,366.82

Ethnical fractionalization index	fractio	230	0.43	0.13	0.18	0.72
Murder date per 100.000 inhabitants	murder	138	9.01	8.28	1.58	46.65
Mortality rate in transit accidents per 100.000 inhabitants	deathroads	228	21.72	7.76	2.47	47.34
Share of population over 25 years with higher education degree	sharedegree	44	11.86	3.99	4.69	22.15

Source: Author's elaboration

Finally, Table 3.3 presents the correlations among the variables that will be used in the analysis. The strongest correlation with the per capita GVA are found between the share of the oil activities and the area of the province. In the case of the oil activities, the relationship among the variables could represent a problem in the regression analysis due to the collinearity between both variables.

In the case of the non-oil per capita GVA, it presents a high correlation with the share of the manufacturing activities, the proportion of urban population, the share of population with higher education degree and the income of the province. This is explained by the fact that the richest provinces in terms of non-oil GVA are the ones that present the highest degrees of urbanization and the highest shares of people with a higher education degree. Also, these provinces hold the largest share of manufacturing activities, which is also positively correlated with the level of human capital. Finally, for the income variable, this is highly related to the amount of population of the province. Because of this, is linked to the proportion of urban population and the share of the manufacturing activities because these variables present higher values in more populated provinces.

Finally, the rest of the covariates do not present relationships that could affect the results of the estimation.

Table 3.3 Correlation table

	GVA per capita	Non-oil GVA per capita	Area (km2)	Proportion of urban population	Share of agriculture in total GVA	Share of manufacture in total GVA	Share of oil activities in total GVA	Influence from neighboring provinces	Total income of the province	Ethnical fractionalization index	Murder rate	Mortality rate in transit accidents	Share of population with university degree
GVA per capita	1.000												
Non-oil GVA per capita	-0.161	1.000											
Area (km2)	0.469	-0.170	1.000										
Proportion of urban population	-0.353	0.739	-0.177	1.000									
Share of agriculture in total GVA	-0.380	-0.147	-0.331	0.090	1.000								
Share of manufacture in total GVA	-0.270	0.792	-0.237	0.622	-0.189	1.000							
Share of oil activities in total GVA	0.843	-0.276	0.616	-0.300	-0.402	-0.442	1.000						
Influence from neighboring provinces	0.430	-0.063	-0.047	-0.511	-0.162	-0.023	0.108	1.000					
Total income of the province	-0.028	0.738	0.141	0.616	-0.156	0.666	-0.161	-0.125	1.000				
Ethnical fractionalization index	0.224	-0.367	0.480	-0.160	0.292	-0.236	0.285	0.103	0.004	1.000			
Murder rate	0.088	0.001	0.246	0.397	0.436	-0.028	0.241	-0.521	0.102	0.462	1.000		
Mortality rate in transit accidents	0.333	-0.261	-0.018	-0.142	0.217	-0.325	0.349	0.075	-0.284	0.281	0.433	1.000	
Share of population with university degree	-0.298	0.808	-0.211	0.503	-0.200	0.656	-0.398	0.045	0.611	-0.464	-0.351	-0.513	1.000

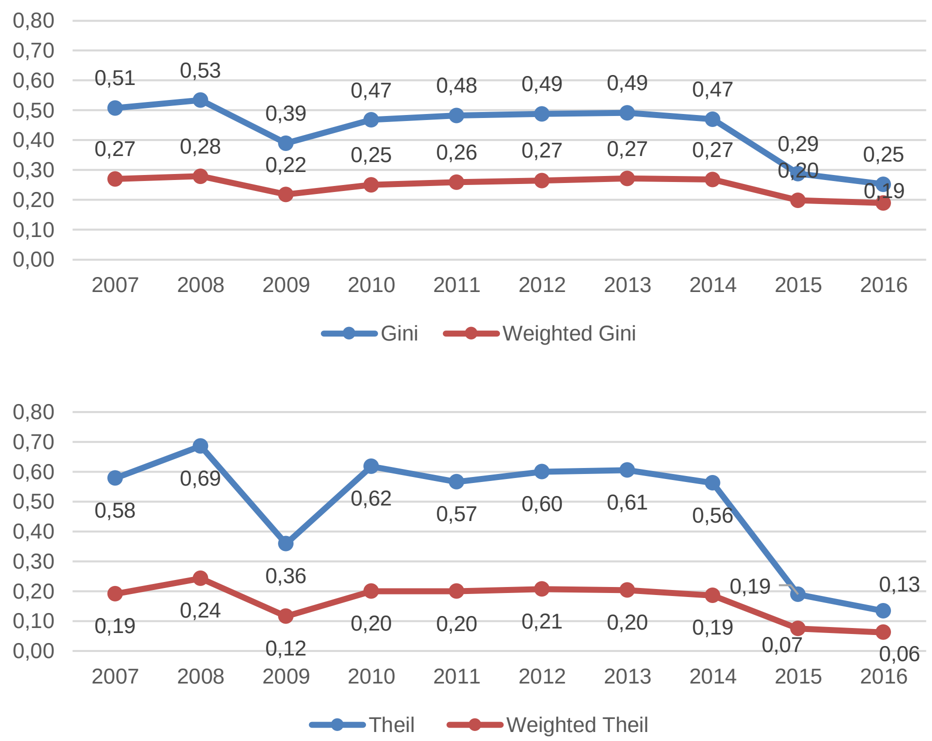
Source: Author's elaboration

3.3 Preliminary evidence

The starting point of the analysis of the regional inequality in Ecuador consist in the presentation of inequality measures such as the Gini and the Theil indices. The population-weighted coefficient of variation, whose use is widespread among the literature, was discarded in the present paper, because it provides a distorted vision of inequality among regions (Gluschenko 2017:4).

From this, on Figure 3.1 it is possible to see that regional inequality shows a decreasing trend along the period of analysis. In the case of the Gini index, it decreases by the half between 2007 and 2014. The weighted Gini coefficient also shows a reduction of eight points and is lower than the unweighted Gini. Theil index also shows a decreasing trend, with a high inequality in 2007 to a value that indicates an almost perfect equality in 2016. It is important to notice that in the years 2009 and from 2014 and on there is a reduction in the amount of inequality between provinces. This inequality has been driven by the periods in which the Ecuadorean economy experienced a contraction, with a decrease in the per capita GVA.

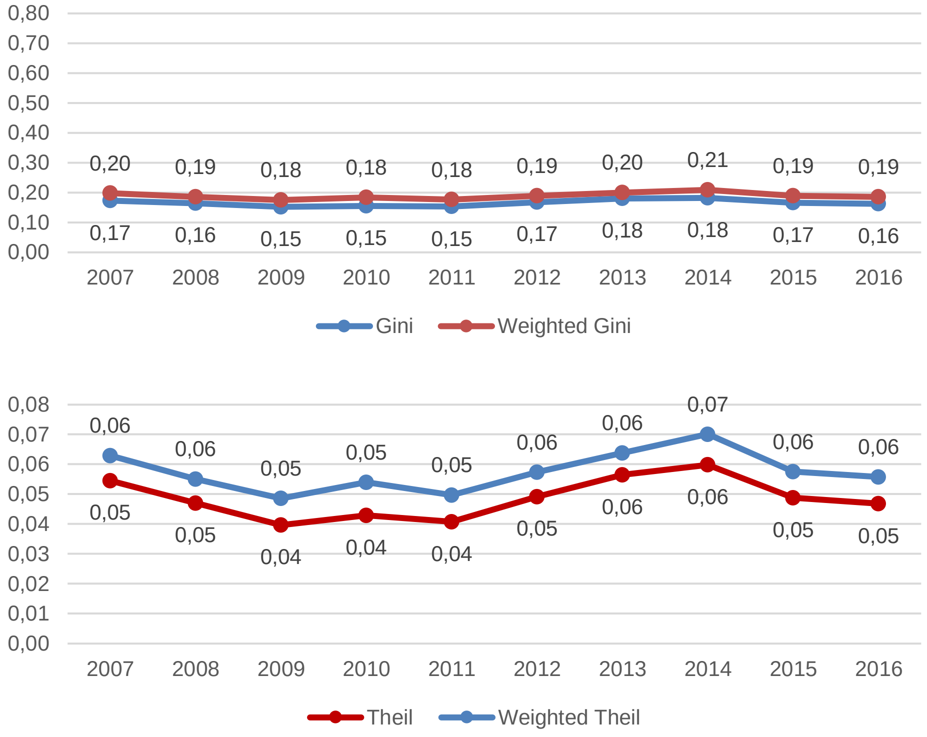
Figure 3.1 Inequality measures for per capita GVA



Source: Author's elaboration

Figure 3.2 displays the values of the inequality indices for the non-oil per capita GVA. In contrast with the total per capita GVA, this variable indicates that there exist less differences among provinces and these have remained constant along the period of analysis. An explanation of this phenomenon is that the non-oil per capita GVA has experienced constant growth rates along the period of analysis and it is less sensible to the effects of international crises that affect the country. In contrast, total per capita GVA is linked with the revenues from the oil exports, whose variation influence the economic cycle of the country.

Figure 3.2 Inequality measures for non-oil per capita GVA



Source: Author's elaboration

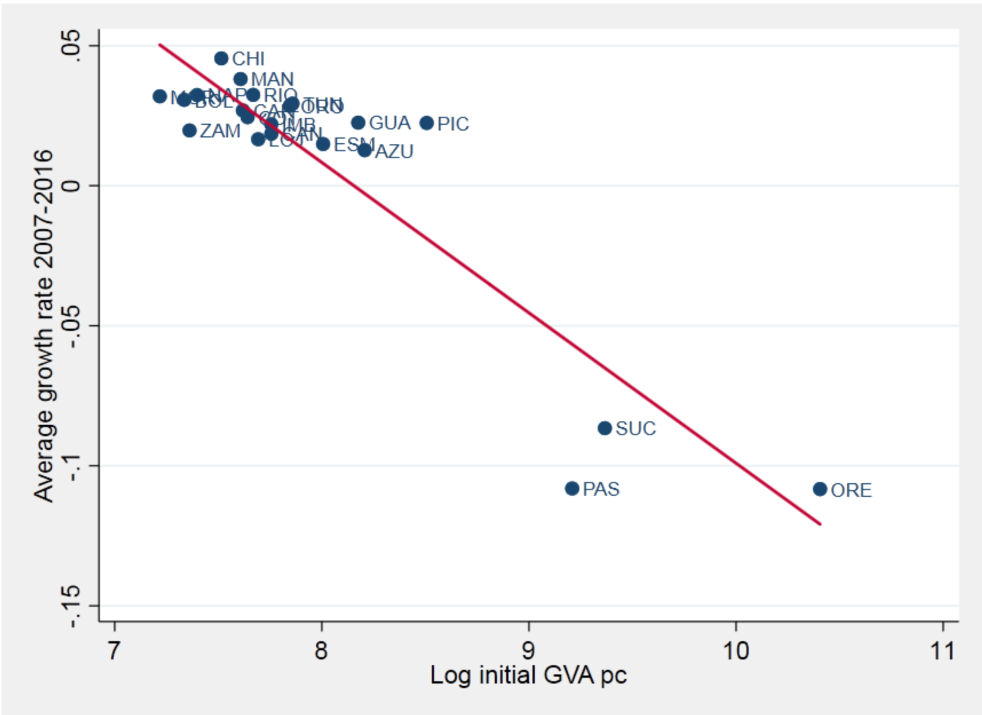
Chapter 4 Convergence across provinces and the regional determinants of growth

In this section, the results of the convergence analysis are presented, both in absolute and conditional terms. The analysis also includes the discussion about the control variables used to determine the factors associated with higher growth rates among regions. In the end, a specific section is dedicated to the analysis of spatial autocorrelation.

4.1 Absolute convergence

In terms of absolute convergence, Figure 4.1 shows that there is a negative relationship between the average growth rate for the period 2007-2016 and the log of the initial per capita GVA. This indicates that there exists absolute β convergence for the Ecuadorean provinces.

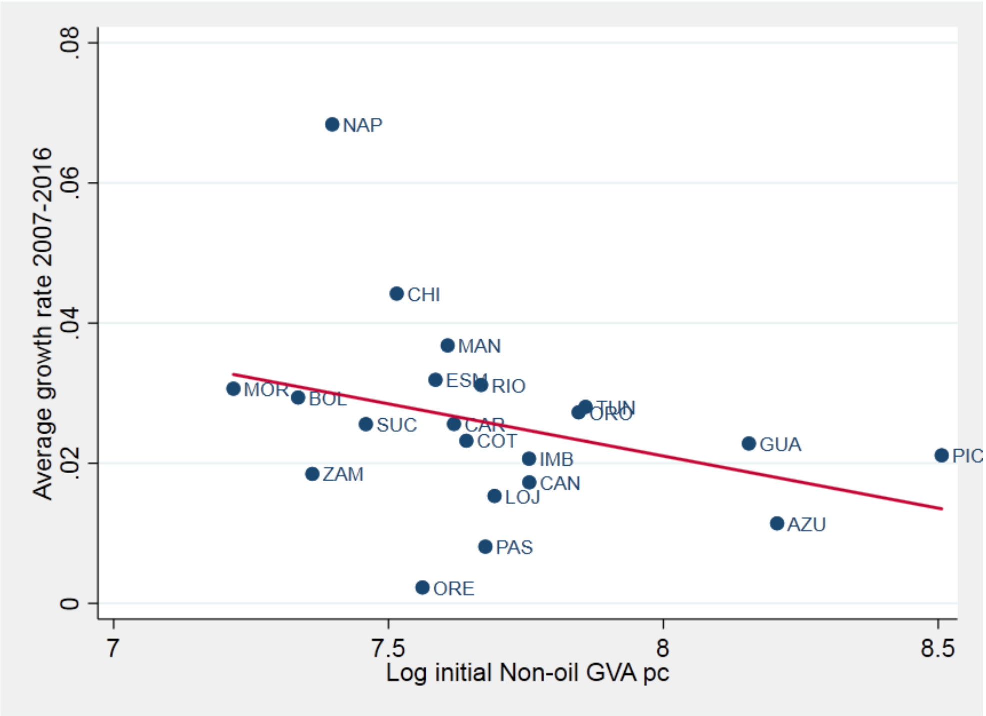
Figure 4.1 Absolute convergence between 2007 initial per capita GVA and its 2007-2016 average growth rate



Source: author’s elaboration

On the other side, from Figure 4.2 it is possible to see that the data does not present a strong negative linear relationship. Because of this, it is not possible to confirm the presence of absolute convergence.

Figure 4.2 Absolute convergence between 2007 initial non-oil per capita GVA and its 2007-2016 average growth rate



Source: author's elaboration

It is possible to test this relationship through a regression analysis, as showed in Table 4.1. Regression (1) represent the relationship of the total per capita GVA against its average growth rate. Regression (2) presents the same calculus but using non-oil per capita GVA. The results for (1) confirm the trend found in Figure 4.1, showing a negative relationship between the log of the initial per capita GVA and its average growth rate. Although the sign of the coefficient is small, the relation is still significant. In the case of the non-oil per capita GVA, the results of the equation (2) are not significant, despite the slope has a negative sign.

With these results, it is possible to calculate the annual convergence rate, which is 0.62% per year for the per capita GVA, and 0.24% for the non-oil per capita GVA. Also, the half-life indicator can also be determined, which measures the amount of time required to disappear half of the initial GVA inequalities. This indicator has a value of 111.74 years for per capita GVA and 284 years for non-oil per capita GVA. This indicates that provinces with a low initial per capita GVA must grow at faster rates to catch up the wealthiest provinces in less time. This because it is possible to see that on Figure 4.1, the average growth rate for the provinces with a low GVA was 0.05%, on average.

Table 4.1 Estimation results for absolute convergence in the period 2007-2016[1]

	(1) Growth in per capita GVA	(2) Growth in non-oil per capita GVA
Initial per capita GVA	-0.0543***	-0.0217
	(0.0069)	(0.0115)
Constant	0.441***	0.189*
	(0.0530)	(0.0887)
R-sq	0.778	0.110
N	23	23

Robust standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001
Total and non-oil per capita GVA is regressed with their corresponding equivalent in the growth rate

By splitting the sample in two subperiods (Table 4.2), it is possible to analyse the behaviour of absolute convergence for each period. Between 2007-2011, equations (1) and (2) show that there are no signs of convergence despite the coefficient of both initial per capita GVA are negative[2]. However, for the period 2011-2016, there is convergence when using total per capita GVA as our variable of interest, as shown in equation (3), which is statistically significant. Finally, equation (4) indicates that there is no convergence in terms of non-oil per capita GVA, due to the non-significance of the overall regression[3].

Table 4.2 Estimation results for absolute convergence in two subperiods

	2007-2011		2011-2016	
	(1) Growth in per capita GVA	(2) Growth in non-oil per capita GVA	(3) Growth in per capita GVA	(4) Growth in non-oil per capita GVA
Initial per capita GVA	-0.0096	-0.0449*	-0.0945***	-0.0004
	(0.0085)	(0.0164)	(0.0120)	(0.0143)
Constant	0.101	0.377**	0.757***	0.0174
	(0.0664)	(0.125)	(0.0939)	(0.115)
R-sq	0.043	0.160	0.776	0.000
N	23	23	23	23

Robust standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001
Total and non-oil per capita GVA is regressed with their corresponding equivalent in the growth rate

4.2 Conditional convergence

This section presents the results of the estimation of conditional convergence, using pooled OLS with cross-section data and random- effects estimation using panel data. Following the procedure of Gennaioli et al. (2014), the pooled OLS estimation was done including regional dummies in a second stage to test for the robustness of the results. In the case of the random-effects, they include time fixed-effects to account for unobservable effects that could be correlated with

[1] For the provinces of Santo Domingo and Santa Elena, the GVA of 2008 was used because they do not had values for 2007.
[2] For equation (1), Prob > F is 0.89 and for (2), Prob > F 0.10
[3] For equation (4), Prob > F is 0.89.

any of the explanatory variables. The independent variables used in the pooled regressions present 5 and 10 period lags, respectively; while the panel data uses one period lag to ensure the exogeneity of these covariates.

To ensure the robustness of the results, several specifications were tested along with the respective statistical tests. In terms of specification, Ramsey's regression specification-error test (RESET) and specification link test were conducted to check for the absence of relevant variables. In terms of multicollinearity, the Variance Inflation Factor (VIF) was calculated to avoid problems of collinearity among predictors. Finally, robust standard errors are used to correct for heteroskedasticity.

4.2.1 Estimation results for per capita GVA

The first set of regressions presented in Table 4.3 correspond to the conditional convergence estimation for per capita GVA between 2007 and 2016. Columns (1) to (4) present the pooled OLS estimation while the remaining present the panel-based regressions for two subperiods: 2007-2011 and 200-2016.

All but one specification shows the existence of conditional convergence between the provinces. The average coefficient is -0.03, which implies a speed of convergence of 0.39% per year, and a half-life of 177 years. In terms of the determinants of growth, all the coefficients and their signs are robust to several specifications. Among the geographical determinants, the logarithm of the area of the province is significant in equation (1), indicating that provinces with a larger surface tend to have reduced growth rates, on average. An increase in 1% in the area of the province is related to a decrease in -0.02% decrease in the growth rate.

From the group of structural determinants of growth, the share of the oil activities in the GVA are statistically significant in regressions (3) and (4). On average, they have a coefficient of -0.0876, which implies that a one point increase in the share of the oil activities in the GVA is related to a decrease in the average growth rate by -0.08%. It is important to say that this variable has a strong correlation with the initial per capita GVA. Because of this, it was tested discarding other regressors.

Finally, only one of the institutional and cultural determinants is statistically significant: total income of the province; which is significant in equations (1) and (2). The average value of the coefficient is 0.0282, which indicates that an increase by 1% in the income of the province is associated with an increase in the growth rate by 0.02%. Nevertheless, it is important to notice the fact that ethnical variables do not influence the growth rates of the province, which could be an indicator of low discrimination among social classes. Also, the share of population with a university degree does not influence the growth rate. This could be explained by the fact that oil activities hold the largest share on the GVA compared to other activities that are more intense in the use of skilled workforce. Because of this, the amount of people with a degree do not influence the growth of the total GVA.

Table 4.3 Conditional convergence - per capita GVA (2007 - 2016)

Dependent variable: Growth in per capita GVA							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	OLS	OLS	OLS	RE	RE	RE
Initial GVApc	-0.0471***	-0.0475***	-0.0218*	-0.0174	-0.0300*	-0.0394***	-0.0386**
	(0.0059)	(0.0069)	(0.0097)	(0.0104)	(0.0127)	(0.0104)	(0.0134)
larea	-0.0247**	-0.0244	-0.0136	-0.0064	-0.0195	-0.0218	-0.0269
	(0.0076)	(0.0110)	(0.0100)	(0.0110)	(0.0180)	(0.0157)	(0.0152)
urban	-0.0251	-0.0373	-0.0446	-0.0539	0.0156	0.0216	0.0801
	(0.0253)	(0.0401)	(0.0336)	(0.0358)	(0.0439)	(0.0420)	(0.0843)
agrishare	0.0222	-0.00475		-0.0652	0.115	0.0498	0.135
	(0.0372)	(0.0645)		(0.0474)	(0.0697)	(0.0704)	(0.112)
manushare	-0.0427	-0.0451			0.0666	0.0310	0.0392
	(0.0810)	(0.0897)			(0.208)	(0.183)	(0.225)
oilshare			-0.0741*	-0.101*			
			(0.0302)	(0.0362)			
fractio	0.0294	0.0249	0.0309	0.0341	0.0205	0.0110	0.0287
	(0.0239)	(0.0227)	(0.0181)	(0.0180)	(0.0361)	(0.0307)	(0.0372)
lincome	0.0292*	0.0272*	0.0113	0.00374	0.0117	0.0255	0.0331
	(0.0114)	(0.0118)	(0.0091)	(0.0116)	(0.0166)	(0.0169)	(0.0220)
deathroads	-0.0005	-0.0004	-0.0001	0.0004	-0.0031	-0.0021	-0.0028
	(0.0006)	(0.0006)	(0.0005)	(0.0005)	(0.0019)	(0.0016)	(0.0019)
sharedegree	0.0008	0.0010	0.0012	0.0009	-0.0007	-0.0032	-0.0047
	(0.0010)	(0.0017)	(0.0012)	(0.0012)	(0.0026)	(0.0031)	(0.0055)
constant	0.478***	0.501***	0.272*	0.224	0.415**	0.488***	0.450***
	(0.0526)	(0.0857)	(0.116)	(0.123)	(0.143)	(0.127)	(0.124)
Region dummy	No	Yes	Yes	Yes	No	No	Yes
Time fixed effects	-	-	-	-	No	Yes	Yes
R-sq	0.968	0.969	0.975	0.977			
adj. R-sq	0.942	0.931	0.950	0.949			
N	21	21	21	21	44	44	44

Robust standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

In addition, Table 4.4 presents the results of the random-effects estimation using panel data with annual growth rates, with several specification to test for the robustness of the results and the effects of the regional dummies and additional covariates. In terms of convergence, the coefficient of the initial GVA (lgva) presents a negative sign and an average value of -0.0892, which is robust to the inclusion of regional dummy variables. These results are in line with the absolute convergence estimation, where poor provinces are catching up the rich ones through higher growth rates. Despite these results, the rate of convergence is low, by 1.04% per year, and the half-life indicator shows that half of the initial GVA inequalities will be reduced in 66.66 years.

In terms of the determinants of growth, equations (1) and (2) show the results without using regional dummies while testing for the effects of different structural variables. The results indicate that none of the structural determinants is correlated with the growth of the GVA. On the other side, the income of the province (lincome), an institutional determinant, is statistically significant in all the specifications and has a positive relation with the growth rates. In this sense, an increase of one percent in the income of the province is related to an increase in the per capita GVA by 0.06%. The significance of this variable is explained by the fact that provinces like Pichincha and Guayas, which have a high average annual growth rate in the period (2.24% and 2.25%, respectively), are the ones that have the highest incomes compared to the rest of the provinces.

Table 4.4 Conditional convergence - per capita GVA (2007 - 2016)

	Dependent variable: Growth in per capita GVA					
	(1)	(2)	(3)	(4)	(5)	(6)
lgva	-0.0576***	-0.145*	-0.0549**	-0.147*	-0.0793***	-0.0514*
	(0.0174)	(0.0656)	(0.0188)	(0.0671)	(0.0224)	(0.0233)
larea	-0.0303	-0.0553	-0.0449	-0.0636	-0.0380*	-0.0500
	(0.0210)	(0.0390)	(0.0245)	(0.0459)	(0.0193)	(0.0258)
urban	-0.107	-0.125	-0.0964	-0.114	-0.0640	-0.136
	(0.0682)	(0.0902)	(0.0879)	(0.110)	(0.0887)	(0.0905)
lincome	0.0589*	0.0910*	0.0627*	0.0954*	0.0617*	0.0531*
	(0.0278)	(0.0387)	(0.0277)	(0.0408)	(0.0271)	(0.0248)
fractio	0.0422	0.0207	0.0401	0.0309	0.0371	0.00368
	(0.0660)	(0.0657)	(0.0571)	(0.0703)	(0.0671)	(0.0550)
deathroads	-0.0019	-0.0018	-0.0023	-0.0019	-0.0012	-0.0030
	(0.0021)	(0.0028)	(0.0022)	(0.0029)	(0.0018)	(0.0026)
agrishare	0.0443		0.126		0.105	0.259
	(0.0904)		(0.125)		(0.134)	(0.162)
manushare	-0.117		-0.0216		0.00871	0.202
	(0.270)		(0.257)		(0.261)	(0.200)
oilshare		0.256		0.256		
		(0.196)		(0.191)		
ninfluence					8.799	2.281
					(8.463)	(4.183)
murder						-0.0015
						(0.0013)
constant	0.572***	1.340	0.641***	1.396	0.671***	0.712***
	(0.154)	(0.705)	(0.189)	(0.732)	(0.146)	(0.184)
Region dummy	No	No	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
R-sq	0.1801	0.1974	0.1824	0.1981	0.2513	0.3911
N	205	205	205	205	184	115

Robust standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

By dividing the analysis in two subperiods, it is possible to analyse if there is still convergence and if the independent variables present a different influence over the initial per capita GVA. In this sense, Table 4.5 shows the results for the pooled OLS estimation between 2007 and 2011. The results indicate that the coefficient of the initial GVA is negative and statistically significant, with an average value of -0.0291. This indicates that there was convergence but with a value close to zero. As a result, there is a low rate of convergence of 0.74% per year. The half-life value indicates that half of the initial GVA inequalities will be reduced in 94.05 years. These results are robust after controlling for unobserved effects that are common for provinces of the same region.

The analysis of the determinants exhibits a consistent behaviour of the independent variables, although some of them loose their significance after controlling for regional effects. For example, the share of population with a higher education degree was significant with a negative effect on growth. In the rest of the cases, the variables are not relevant to explain the variance in the growth in the per capita GVA, which can be confirmed by the low values of the determination coefficients.

Table 4.5 Conditional convergence - per capita GVA (2007 - 2011)

Dependent variable: Growth in per capita GVA		
	(1)	(2)
Initial GVApc	-0.0313***	-0.0268*
	(0.0064)	(0.0086)
larea	0.0051	-0.0041
	(0.0120)	(0.0170)
urban	-0.0053	-0.0075
	(0.0253)	(0.0446)
agrishare	-0.133	-0.0757
	(0.0648)	(0.0762)
manushare	-0.201	-0.150
	(0.143)	(0.172)
lincome	0.0208	0.0213
	(0.0114)	(0.0149)
fractio	-0.0125	-0.0127
	(0.0337)	(0.0402)
deathroads	0.0012	0.0009
	(0.0009)	(0.0009)
sharedegree	-0.00395*	-0.00284
	(0.0014)	(0.0021)
constant	0.212*	0.232*
	(0.0905)	(0.0960)
R-sq	0.675	0.702
adj. R-sq	0.409	0.337
N	21	21

Robust standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

For the period between 2011 and 2016, the results are displayed on Table 4.6. Equations (1) to (3) show the pooled OLS estimation while equations (4) to (7) show the random-effects estimation using panel data with annual growth rates. The estimations show that the initial per capita GVA (lgva) is statistically significant in three of seven specifications. It has an average value of -0.0395, which implies a convergence speed of 1.01% per year, higher than the estimated speed of the previous period which was 0.74%. Also, the half-life indicator reduces to 68.80 years. In the rest of the specifications, the initial GVA is highly correlated with the share of the oil activities. As a result, the coefficient of the initial GVA losses its precision due to the collinearity between these variables, losing its statistical significance.

The availability of more information in this period made it possible to include additional covariates in the analysis. In this sense, variables like the influence of neighboring provinces (ninfluence) have a strong influence on the average growth rate, as shown on equation (1). However, the result is not robust to the inclusion of other covariates. On the other side, the murder rates, which attempt to capture the effect of the institutional environment, do not have an influence on growth rates. Another variable that shows a significant relationship with the growth of the per capita GVA is the share of the oil activities in the total GVA, which is statistically significant in three specifications, even after controlling for regional effects. The coefficient of this variable shows a negative relationship with the GVA per capita: an increase in 1 point in the share of the oil activities in the GVA is related to a decrease in the growth rate by 0.19 percentage points, on average. Beside these variables, the rest of covariates do not explain the variation in the average growth rate.

Table 4.6 Conditional convergence - per capita GVA (2011 - 2016)

	Dependent variable: Growth in per capita GVA						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	OLS	OLS	RE	RE	RE	RE
lgva	-0.0956***	-0.0347	-0.0398	-0.0575**	-0.0083	-0.0514*	0.0108
	(0.0136)	(0.0255)	(0.0274)	(0.0216)	(0.0156)	(0.0233)	(0.0176)
larea	-0.0103	-0.00940	-0.0115	-0.0367*	-0.0352**	-0.0500	-0.0300
	(0.0234)	(0.0157)	(0.0153)	(0.0144)	(0.0118)	(0.0258)	(0.0231)
urban	-0.00565	-0.0488	-0.0285	-0.0862	-0.0758	-0.136	-0.164*
	(0.0611)	(0.0506)	(0.0417)	(0.0645)	(0.0562)	(0.0905)	(0.0835)
agrishare	0.00134	-0.0839		0.227*		0.259	
	(0.115)	(0.0711)		(0.109)		(0.162)	
manushare	0.0932		0.0376	0.133		0.202	
	(0.159)		(0.0990)	(0.199)		(0.200)	
oilshare		-0.173*	-0.144		-0.197***		-0.224***
		(0.0655)	(0.0728)		(0.0380)		(0.0534)
ninfluence	5.108*	2.612	2.586	2.520	3.119	2.281	2.290
	(2.139)	(1.544)	(1.250)	(4.438)	(4.446)	(4.183)	(4.108)
lincome	0.0257	0.00796	0.0128	0.0480*	0.0276*	0.0531*	0.0237
	(0.0203)	(0.0147)	(0.0142)	(0.0239)	(0.0121)	(0.0248)	(0.0183)
fractio	-0.0471	0.0197	0.0061	0.0317	0.0994	0.0037	0.0466
	(0.0438)	(0.0553)	(0.0404)	(0.0444)	(0.0565)	(0.0550)	(0.0485)
deathroads	-0.0005	-0.0004	-0.0007	-0.0026	-0.0023	-0.0030	-0.0021
	(0.0012)	(0.0011)	(0.0011)	(0.0022)	(0.0018)	(0.0026)	(0.0020)
murder	0.0017	0.0018	0.0014	-0.0011	0.0004	-0.0015	-0.0005
	(0.0014)	(0.0009)	(0.0010)	(0.0013)	(0.0009)	(0.0013)	(0.0013)
sharedegree	0.0008	0.0021	0.0012				
	(0.0036)	(0.0026)	(0.0025)				
_cons	0.679**	0.314	0.346	0.605**	0.287*	0.712***	0.230
	(0.194)	(0.199)	(0.199)	(0.190)	(0.123)	(0.184)	(0.206)
Region dummy	Yes	Yes	Yes	No	No	Yes	Yes
Time fixed effects	-	-	-	Yes	Yes	Yes	Yes
R-sq	0.973	0.984	0.982	0.3849	0.3868	0.3911	0.3997
adj. R-sq	0.933	0.962	0.955	-	-	-	-
N	23	23	23	115	115	115	115

Robust standard errors in parentheses

* p<0.05 ** p<0.01 *** p<0.001

4.2.2 Estimation results for non-oil per capita GVA

The following section presents the results of the conditional convergence analysis for the non-oil per capita GVA. The first part corresponds to the analysis of the complete period and the subsequent parts include the analysis of the sample divided by subperiods. In this section, since the dependent variable is the non-oil GVA per capita, it is possible to get an accurate vision of the determinants of the economic growth without the influence of the oil activities that could distort the analysis.

The analysis for the complete period is displayed in Table 4.7. Columns (1) to (4) present the pooled OLS estimation while the remaining present the panel-based regressions for two subperiods: 2007-2011 and 200-2016. The results of the analysis indicate that there is no evidence of conditional convergence when OLS is used. Also, the direction and the magnitude of the effect is similar to the one found in the absolute convergence analysis. However, when testing the relationship using panel data, the information shows the existence of convergence with an average coefficient of -0.091, higher than the coefficient of -0.0217 found in the absolute convergence analysis. This implies that provinces are converging at a rate of 0.96% per year, and that half of the starting per capita GVA inequalities will be reduced in 72.45 years.

The independent variables present a different behaviour due to the change in the dependent variable. For example, the area of the province is statistically significant in four specifications and has a negative influence over the growth rates, with an average magnitude of -0.0244. This indicates that an increase of one point in the area of the province is associated with a decrease in the average growth rate of -0.02%. An explanation for this phenomenon is that the provinces of the Amazon region are ranked as the largest of the country and hold a high degree of participation of the oil industry in their total GVA. However, a positive sign is expected because a larger size could also be associated with a higher stock of natural resources.

In the case of the structural determinants, the share of the manufacturing activities is statistically significant in three specifications and the direction of the effect is consistent with the literature. On average, the coefficient of this variable indicates that one point increase in the share of the manufacture in the non-oil GVA is associated with an increase in the growth rate by 0.14%, on average. This finding is interesting in the sense that regional inequality is caused by an uneven structural change between regions, and this structural change is mainly driven by an increase of the importance of industrial activities on GDP (Hassan 2004:1). Another variable that holds a significant result is the share of population with higher education. Despite the variable has a minimum effect on the average growth rates, the fact that it has a positive and significant influence confirms the notion that human capital is a crucial determinant of productivity (Gennaioli et al. 2014:281).

Table 4.7 Conditional convergence – Non-oil per capita GVA (2007 - 2016)

	Dependent variable: Growth in non-oil per capita GVA						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	OLS	OLS	OLS	RE	RE	RE
Initial GVApc	-0.0292	-0.0307	-0.0297	-0.0258	-0.0870**	-0.110***	-0.0767***
	(0.0172)	(0.0201)	(0.0167)	(0.0217)	(0.0337)	(0.0184)	(0.0221)
larea	-0.0235*	-0.0241*	-0.0242*	-0.0258*	0.0011	-0.0130	-0.0059
	(0.0083)	(0.0096)	(0.0081)	(0.0106)	(0.0094)	(0.0077)	(0.0123)
urban	-0.0521	-0.0503	-0.0559	-0.0532	0.0222	0.0841*	0.0568
	(0.0413)	(0.0444)	(0.0389)	(0.0427)	(0.0254)	(0.0340)	(0.0363)
agrishare	0.0142	0.0155			0.0574	0.152***	
	(0.0289)	(0.0294)			(0.0413)	(0.0399)	
manushare	0.105*	0.0977	0.0967*		0.151	0.227*	
	(0.0371)	(0.0527)	(0.0331)		(0.137)	(0.0931)	
oilshare				-0.0011			-0.0299
				(0.0117)			(0.0240)
lincome		0.0013		0.0060	0.0058	0.0151*	0.0140
		(0.0074)		(0.0064)	(0.0095)	(0.0069)	(0.0073)
fractio	0.0198	0.0203	0.0199	0.0237	-0.0134	-0.0017	0.0287
	(0.0203)	(0.0223)	(0.0194)	(0.0228)	(0.0317)	(0.0202)	(0.0258)
deathroads	0.0001	0.00005	0.0001	-0.0001	-0.0001	-0.0004	-0.0001
	(0.0004)	(0.0005)	(0.0004)	(0.0004)	(0.0007)	(0.0005)	(0.0007)
sharedegree	0.0044*	0.0043*	0.0044**	0.0043*	0.0017	0.0019	0.0008
	(0.0014)	(0.0015)	(0.0014)	(0.0016)	(0.0018)	(0.0020)	(0.0025)
constant	0.424**	0.433*	0.439**	0.405*	0.627*	0.815***	0.558*
	(0.116)	(0.138)	(0.116)	(0.160)	(0.245)	(0.139)	(0.224)
Region dummy	Yes	Yes	Yes	Yes	No	Yes	Yes
Time fixed effects	-	-	-	-	Yes	Yes	Yes
R-sq	0.761	0.762	0.758	0.731			
adj. R-sq	0.522	0.47	0.561	0.461			
N	21	21	21	21	44	44	44

Robust standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

The results of the random-effects regressions are displayed in Table 4.8. The first row of the results indicates that the initial GVA (lgva2) becomes statistically significant in five of six specifications, as opposed to the results of the absolute convergence regression. However, the average value of the coefficient is low and close to zero. It also shows an average rate of convergence of 0.92% and a half-life of 75.47 years.

In this set of results, the share of urban population (urban) is the only demographic determinant which is statistically significant in three specifications. The variable has a positive effect on growth, and the average coefficient indicates that a one point increase in the share of the urban population is associated with an increase in the growth rate by 0.1 points.

In the same sense, the structural determinants are statistically significant in equations (3) and (6) and they have a positive relation with the growth rates. In the case of the share of agricultural activities, an increase in one point in the share of the agricultural activities in the non-oil per capita GVA is associated with an increase in the growth rates by 0.24 points. For the manufacturing activities, an increase by pone point in the share of this sector is associated with an increase in by 0.38 points, on average. On the other side, the share of the oil activities is negative, and it is only significant in equation (4). Finally, the income of the province (lincome) is also significant in the specification (3), and its associated with an increase in the growth rates of 0.02 points.

Table 4.8 Conditional convergence – Non-oil per capita GVA (2007 - 2016)

	Dependent variable: Growth in non-oil per capita GVA					
	(1)	(2)	(3)	(4)	(5)	(6)
lgva2	-0.0678**	-0.0473*	-0.126***	-0.0749**	-0.107***	-0.0530
	(0.0240)	(0.0214)	(0.0202)	(0.0246)	(0.0210)	(0.0468)
larea	0.0075	0.0082	-0.0057	0.0064	-0.0030	-0.0052
	(0.0117)	(0.0127)	(0.0074)	(0.0135)	(0.0081)	(0.0094)
urban	-0.0027	0.0031	0.122***	0.0699*	0.106**	-0.0104
	(0.0292)	(0.0265)	(0.0321)	(0.0328)	(0.0323)	(0.0771)
lincome	0.0070	0.0118	0.0167*	0.0156	0.0123	0.0123
	(0.0130)	(0.0109)	(0.0084)	(0.0091)	(0.0080)	(0.0120)
fractio	-0.0327	0.0001	-0.0209	0.0288	0.0194	0.0372
	(0.0394)	(0.0245)	(0.0281)	(0.0320)	(0.0327)	(0.0509)
deathroads	0.0004	0.0008	-0.0002	0.0008	-0.0002	0.0002
	(0.0006)	(0.0007)	(0.0004)	(0.0007)	(0.0005)	(0.0007)
agrishare	0.0961		0.259***		0.216***	0.0576
	(0.0557)		(0.0468)		(0.0503)	(0.0794)
manushare	0.230		0.403***		0.362**	0.199
	(0.180)		(0.104)		(0.113)	(0.113)
oilshare		-0.0459		-0.0532*		
		(0.0267)		(0.0265)		
ninfluence					-2.840	-4.417
					(3.204)	(5.020)
murder						0.0005
						(0.0006)
_cons	0.420*	0.245	0.801***	0.389	0.690***	0.412
	(0.176)	(0.221)	(0.140)	(0.224)	(0.129)	(0.260)
Region dummy	No	No	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-sq	0.1910	0.1910	0.2559	0.2144	0.2738	0.1621
N	205	205	205	205	184	115

Robust standard errors in parentheses

* p<0.05 ** p<0.01 *** p<0.001

In the case of the convergence for the period between 2007 and 2011, the results are presented on Table 4.9. The coefficients of the initial non-oil per capita GVA are statistically significant and have a negative sign. However, the magnitude of the coefficient is sensitive to changes in the specification of the model. The average value of the coefficient is -0.0842, which indicates that the average speed of convergence for the period is around 2.2% per year, with al half-life of 31.52 years.

In terms of the geographic and demographic determinants of growth, the area of the province shows a statistically significant coefficient for equation (1). The sign indicates that there is an inverse relationship, which shows that a 1% increase in the area of the province is related to a reduction in the rate of growth by 0.02%, on average.

On the other side, the economic structure of the provinces does not have an influence over the growth rate of the non-oil GVA per capita. This result could be influenced by the incorporation of the regional dummy variable, which may capture the effect of the economic structure of the amazon provinces that hold a large share of oil activities.

Table 4.9 Conditional convergence – Non-oil per capita GVA (2007 - 2011)

Dependent variable: Growth in non-oil per capita GVA		
	(1)	(2)
Initial GVApc	-0.103**	-0.0654*
	(0.0309)	(0.0238)
larea	-0.0221*	-0.0061
	(0.0090)	(0.0117)
urban	0.0867	0.0619
	(0.0483)	(0.0354)
agrishare	0.114	
	(0.0671)	
manushare	0.188	
	(0.1100)	
oilshare		-0.04
		(0.0236)
lincome	0.0074	
	(0.0107)	
fractio	-0.0421	-0.0255
	(0.0261)	(0.0322)
deathroads	-0.0004	0.0003
	(0.0011)	(0.0008)
sharedegree	0.0028	0.0014
	(0.0017)	(0.0020)
constant	0.901**	0.553*
	(0.2560)	(0.2320)
Region dummy	Yes	Yes
R-sq	0.729	0.687
adj. R-sq	0.398	0.431
N	21	21

Robust standard errors in parentheses

* p<0.05 ** p<0.01 *** p<0.001

For the period 2011-2016, the results are presented in Table 4.10. As the previous case, several specifications are analysed to show the effect of distinct group of variables. Columns (1) and (2) show the regression results for the pooled OLS while columns (3) to (6) show the estimation results using panel data with annual growth rates.

Compared to the previous period, there are more control variables available to perform the analysis. In first place, the coefficient of the initial non-oil per capita GVA is not statistically significant in any of the specifications, which is consistent with the results of the absolute convergence analysis.

In terms of the determinants of growth, the only specification that has statistically significant results is equation (3). In this specification, the share of the manufacture sector in the GVA shows a positive and significant relationship. An increase in the share of the manufacturing activities is associated with an in crease in the growth of the non-oil per capita GVA by 0.17 points. However, this result is not robust under several specifications.

Finally, it is worth to mention that the lack of the significance of the variables could also be related by the low explanatory power of the model. The average value of the R-squared coefficient for the panel regressions is 0.16 while for the OLS, the average coefficient is 0.57.

Table 4.10 Conditional convergence – Non-oil per capita GVA (2011 - 2016)

	Dependent variable: Growth in non-oil per capita GVA					
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	RE	RE	RE	RE
lgva2	-0.0719	-0.0765	-0.0344	-0.0181	-0.0530	-0.0296
	(0.0429)	(0.0493)	(0.0246)	(0.0242)	(0.0468)	(0.0361)
larea	-0.0034	-0.0031	-0.0097	-0.0121	-0.0052	-0.0035
	(0.0120)	(0.0131)	(0.0068)	(0.0087)	(0.0094)	(0.0086)
urban	0.0291	0.0275	-0.0438	-0.0480	-0.0104	-0.0235
	(0.0793)	(0.0829)	(0.0312)	(0.0308)	(0.0771)	(0.0611)
agrishare			0.0433		0.0576	
			(0.0342)		(0.0794)	
manushare		0.0289	0.177*		0.199	
		(0.130)	(0.0894)		(0.113)	
oilshare	-0.0335	-0.0327		-0.0217		-0.0233
	(0.0312)	(0.0347)		(0.0217)		(0.0256)
ninfluence	3.550	3.508	-4.513	-4.265	-4.417	-4.260
	(1.941)	(2.134)	(4.916)	(4.832)	(5.020)	(4.894)
lincome	0.011	0.0098	0.0125	0.0184	0.0123	0.0155
	(0.0096)	(0.0122)	(0.0109)	(0.0103)	(0.0120)	(0.0099)
fractio	0.0117	0.0103	0.0345	0.0511	0.0372	0.0532
	(0.0482)	(0.0515)	(0.0502)	(0.0403)	(0.0509)	(0.0483)
deathroads	0.0002	0.0002	0.0001	0.0001	0.0002	0.0003
	(0.0008)	(0.0009)	(0.0005)	(0.0005)	(0.0007)	(0.0006)
murder	0.0012	0.0012	0.0003	0.0005	0.0005	0.0006
	(0.0007)	(0.0007)	(0.0005)	(0.0005)	(0.0006)	(0.0006)
sharedegree	0.0035	0.0038				
	(0.0036)	(0.0039)				
constant	0.435	0.469	0.343**	0.219	0.412	0.221
	(0.261)	(0.304)	(0.130)	(0.141)	(0.260)	(0.187)
Region dummy	Yes	Yes	No	No	Yes	Yes
Time fixed effect	-	-	Yes	Yes	Yes	Yes
R-sq	0.568	0.569	0.1559	0.1529	0.1621	0.1602
adj. R-sq	0.049	-0.053	-	-	-	-
N	23	23	115	115	115	115

Robust standard errors in parentheses

* p<0.05 ** p<0.01 *** p<0.001

4.2.3 The analysis of spatial autocorrelation

In this section, the analysis focuses on the analysis of spatial correlation that may arise among the analysed provinces.

Spatial correlation is defined as "the correlation among observations of a single variable strictly attributable to the proximity of those observations in geographic space" (Fischer and Wang 2011:22). It measures how one data point is similar to another one in the space. Spatial autocorrelation must be analysed since one main assumption in statistics is that the data is randomly distributed. In this case, spatial units must be randomly distributed.

Spatial correlation is calculated using Moran's I autocorrelation index. It is used to measure global spatial correlation by considering all the spatial associations in the calculation. Moran's I is given by the expression (Fischer and Wang 2011:23):

$$I = \frac{n}{W_0} * \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij}(z_i - \bar{z})(z_j - \bar{z})}{\sum_{i=1}^{n} (z_i - \bar{z})^2}$$

With the normalizing factor

$$W_0 = \sum\nolimits_{i=1}^{n} \sum\nolimits_{j \neq i}^{n} W_{ij}$$

Where:

n is the number of areas in the sample,

i, j are to of the area units,

z_i is the value of the variable of interest for region i, and

W_{ij} is the similarity of locations i and j, with W_{ij} for all i.

The inference of this indicator is based on a null hypothesis of spatial randomness. This means that neighbouring areas do not influence each other and that there is independence and spatial randomness (Fischer and Wang 2011:23). On the other side, the alternative hypothesis implies that areas with large values are surrounded by similar ones (positive spatial autocorrelation), or that areas with small values are surrounded by ones with large values (negative spatial autocorrelation). Because of this, Moran's I take vales between -1 (perfect dispersion or clustering of dissimilar values), 0 (perfect randomness) and +1 (perfect autocorrelation or clustering of similar values). For the present exercise, the significance of the index was calculated using two criteria: the analytical approach and the Monte Carlo approach (Gimond 2018, no page). This statistic was calculated using the R statistical software (R Core Team 2013) and the package *spdep* (Bivand and Piras 2005).

The Moran's I statistic for per capita GVA is shown in Table 4.11. For this variable, the Moran's I statistic shows statistically significant results for the years between 2007 and 2015. Although the value of the statistic is close to zero, it indicates that there is a low positive but significant positive spatial autocorrelation.

Table 4.11 Moran's I statistic for per capita GVA

Year	Moran I statistic			
	Analytical	p-value	Monte Carlo	p-value
2007	0.189	0.000	0.189	0.002
2008	0.177	0.000	0.177	0.005
2009	0.159	0.001	0.159	0.005
2010	0.052	0.003	0.052	0.005
2011	0.193	0.000	0.194	0.007
2012	0.135	0.000	0.136	0.007
2013	0.124	0.001	0.124	0.008
2014	0.097	0.002	0.097	0.015
2015	0.074	0.049	0.074	0.048
2016	0.038	0.162	0.038	0.155

Source: Author's elaboration

For the non-oil per capita GVA (Table 4.12), the p-value of the statistic does not allow to reject the null hypothesis of spatial randomness. Because of this, it is possible to say that the data does not present any form of spatial autocorrelation, despite the indicator is negative.

Table 4.12 Moran's I statistic for non-oil per capita GVA

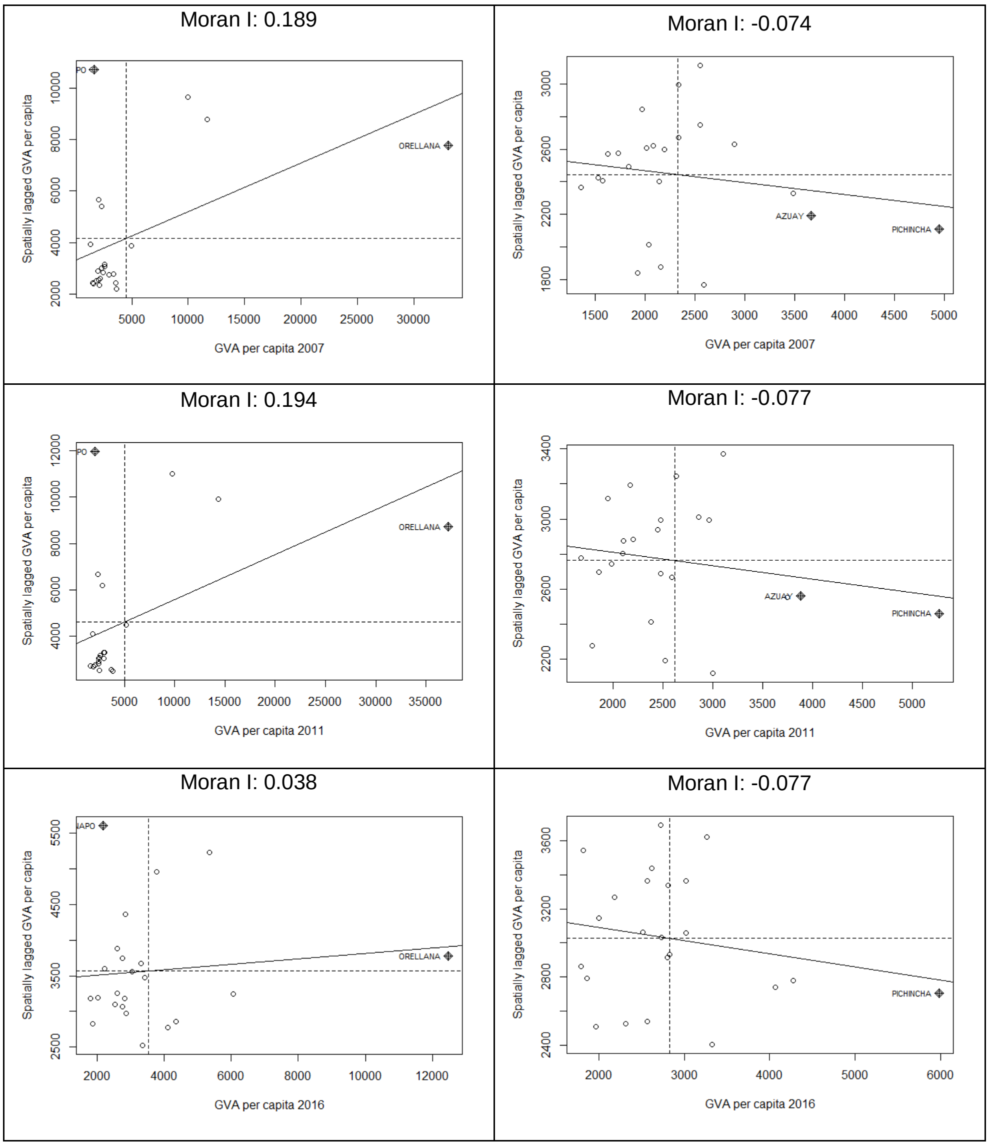
Year	Moran I statistic			
	Analytical	p-value	Monte Carlo	p-value
2007	-0.073	0.599	-0.074	0.583
2008	-0.061	0.555	-0.061	0.510
2009	-0.076	0.606	-0.076	0.570
2010	-0.082	0.629	-0.082	0.595
2011	-0.077	0.611	-0.077	0.608
2012	-0.062	0.559	-0.062	0.480
2013	-0.062	0.560	-0.062	0.543
2014	-0.062	0.561	-0.062	0.537
2015	-0.083	0.634	-0.083	0.607
2016	-0.077	0.613	-0.077	0.582

Source: Author's elaboration

As a complement to this analysis, the Moran scatterplot is presented for a sample of three years to show the behaviour of the spatial autocorrelation (Table 4.13). The first column indicates the Moran scatterplot for the total per capita GVA while the second shows the scatterplot for non-oil GVA. In the first column, it is possible to see that the slope, which is the value of the statistic, remains positive for the three years. Also, for the years 2007 and 2011, there is a clustering of poor provinces in quadrant 3 and a dispersion of wealthy provinces in the first quadrant. The province that causes this dispersion is Orellana, which is the wealthiest of the sample due to the influence of the oil activities in its GVA.

In the case of the non-oil GVA (second column), the scatterplots confirm the results of the non-significance of the Moran statistic. In contrast with the first column, the provinces present a higher dispersion, with the presence of provinces of low non-oil GVA surrounded by provinces with high non-oil GVA (quadrant 2), and vice versa (quadrant 4). Because of this, the value of the Moran statistic has a negative slope for the entire period.

Table 4.13 Moran scatterplot for the years 2007, 2011, 2016



Source: Author's elaboration

With these findings, it is possible to affirm that spatial autocorrelation is not a major concern with the present data. In the case of the per capita GVA, although the indicator shows a significant result, its magnitude is close to zero, so no bias is expected. For the non-oil per capita GVA, the results show that the data does not present spatial autocorrelation.

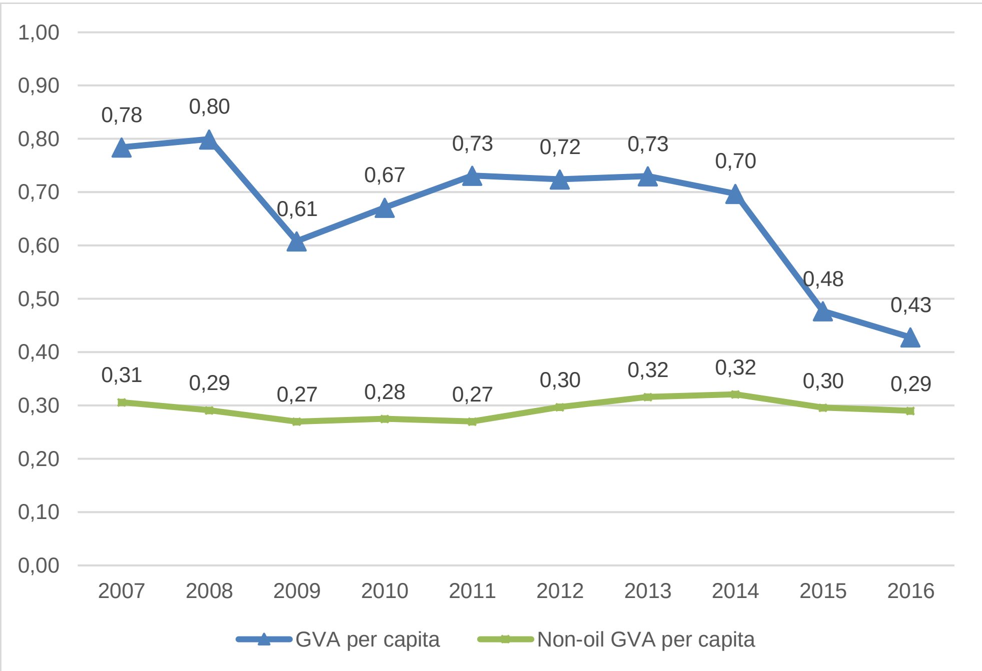
Chapter 5 The distributional approach to convergence

The analysis of the dynamics of the income distribution is a complement to the traditional analysis of convergence since it allows to understand the evolution and the dispersion of the GVA, beyond the traditional concept of absolute and conditional convergence (Durlauf et al. 2005:592). In this sense, in order to understand if there is a reduction in the gap between rich and poor provinces, two approaches are taken to analyse the dynamics of the distribution of the GVA: the sigma convergence analysis (Barro and Sala-i-Martin 2004) and the analysis of the modality of the income distribution (Tirado et al. 2016).

5.1 Sigma convergence

In terms of sigma convergence, which measures the dispersion of the logarithm of the GVA per capita, the results are presented in Figure 5.1. In the case of the total GVA, the curve indicates that there has been an important reduction of the dispersion of the income in the period of analysis, with a reduction of 35 points between 2007 and 2016. In the case of the non-oil GVA, the curve indicates that the dispersion of the income has remained constant along the period of analysis.

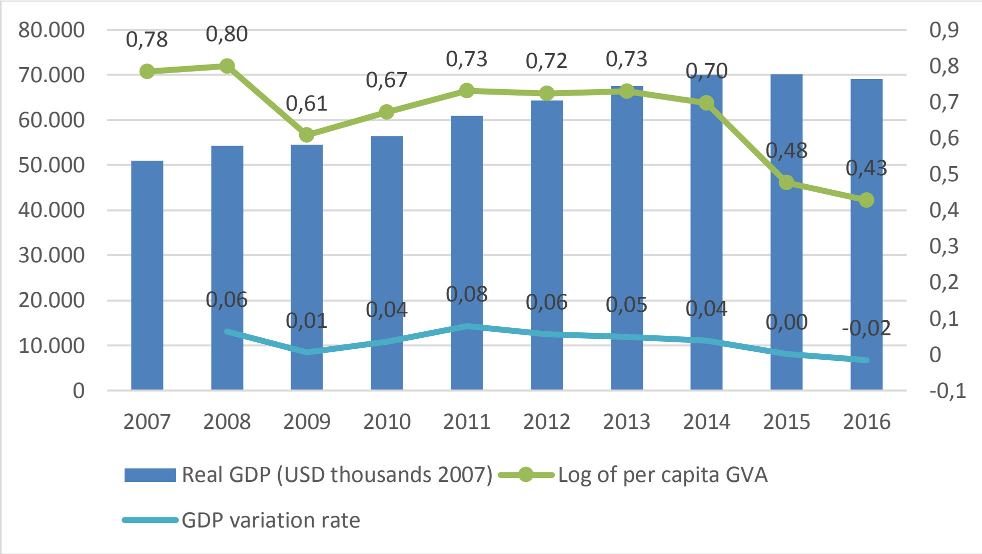
Figure 5.1 Sigma convergence



Source: Author's elaboration

By relating the dispersion of the logarithm of the total per capita GVA with the behaviour of the economy, it is possible to see that the dispersion is highly associated with the economic cycle (Figure 5.2). Because of this, the periods where the economy had experienced higher rates of economic growth, the difference between the incomes of the provinces has widened.

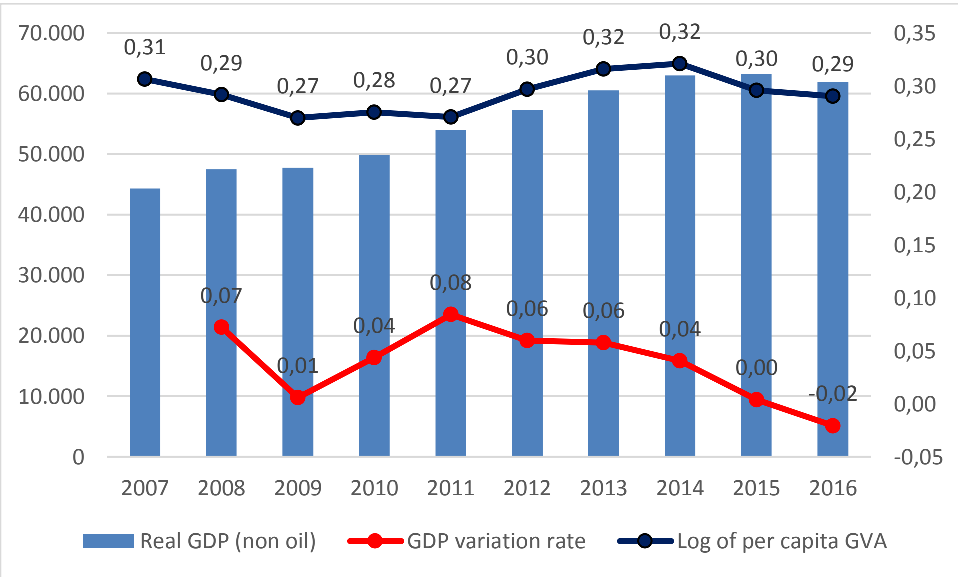
Figure 5.2 Dispersion of total GVA and growth rate of the real GDP



Source: Author's elaboration

In the case of the non-oil GVA, it is possible to see that its behaviour is less related to the growth rate of the economy (Figure 5.3). Because of this, the indicator keeps a steady trend along the period of analysis, with the lowest values between the years 2009 and 2011, which are related to the impact of the global financial crises in the Ecuadorean GDP and its growth rate.

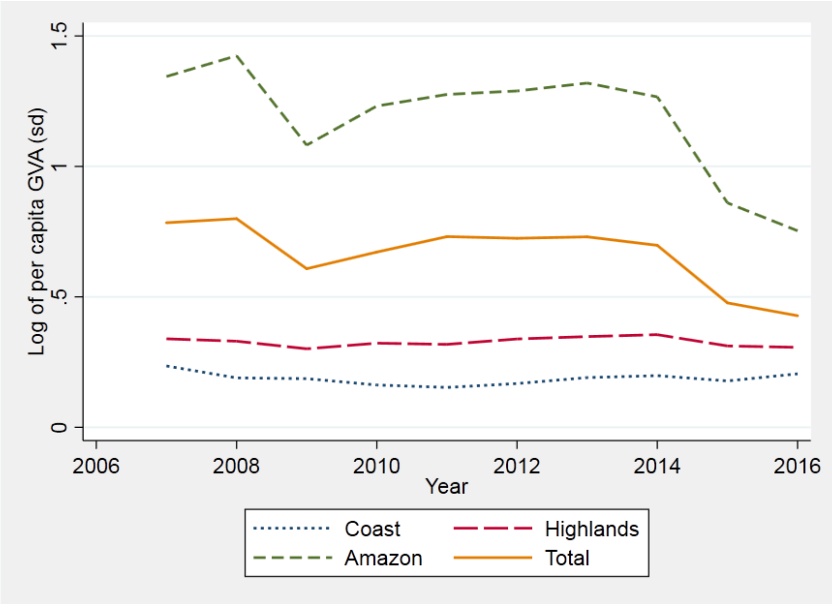
Figure 5.3 Dispersion of non-oil GVA and growth rate of the real GDP



Source: Author's elaboration

In terms of regions, Figure 5.4 shows the results of the sigma convergence of the natural regions of Ecuador. The plot shows that there has been a reduction in the dispersion of the per capita GVA, mainly driven by the behaviour of the Amazon region, which holds the greatest spread. In this sense, this variability is caused by an uneven distribution of the oil activities, which are concentrated on the northern provinces of this region. However, despite the southern provinces hold large deposits of minerals, these have not been exploited thus they do not contribute to a larger share of GVA. In the case of the Coastal region, the provinces of this region are not located on the extremes of the income distribution and they hold relative similar levels of per capita GVA. In the case of the provinces located on the Highlands, they present a larger dispersion due to the presence of the provinces of Pichincha and Azuay, which present high levels of per capita GVA.

Figure 5.4 Sigma convergence for regions – per capita GVA

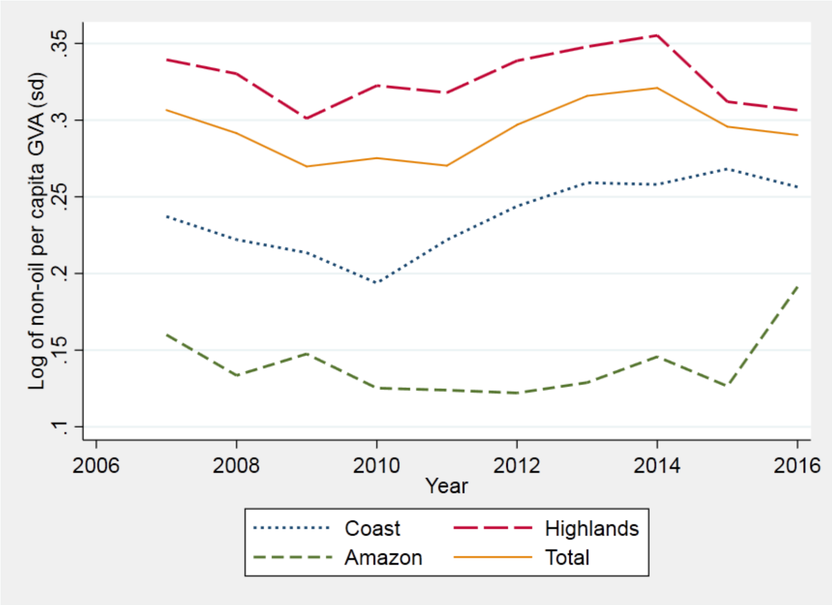


Source: Author's elaboration

In the case of non-oil per capita GVA, Figure 5.5 presents the evolution of the dispersion of this variable during the period of analysis. Despite that the total dispersion remains constant, the evolution of sigma convergence presents a different pattern for every region. First, the provinces located in the Highlands present a higher dispersion because of the province of Pichincha, where the capital of the country is located. In 2016, this province had a per capita GVA 3 times larger than the lowest per capita GVA of the region. However, the trend has remained stable between 2007 and 2016.

In the case of the provinces located in the Coastal region, they present a dispersion below the total for the period but that has raised from 2010. This has been caused by the divergence between the province of Guayas from the rest of the regions, which in 2007 had a non-oil per capita GVA 1.77 larger than the poorest province of the region, but in 2016 the difference peaked to 2.35 times the lowest per capita GVA of the region. Finally, the Amazon region shows low and constant value, with an increase from the year 2015 caused by the growth of the non-oil GVA of the province of Napo.

Figure 5.5 Sigma convergence for regions – non-oil per capita GVA



Source: Author's elaboration

5.2 The modality of the income distribution

The analysis of the modality of the income distribution is a complement to the convergence analysis because it allows to know if there is persistence, stratification or polarization among rich and poor provinces (Quah 1996b:1046). Following the procedure described by Tirado et al. (2016), kernel densities and boxplots of the GVA distribution are presented to analyse the patterns of the income distribution.

The kernel density is a tool that can provide information of the properties of a dataset, such as skewness or multimodality of the data (Silverman 1986:1). The process of creating a kernel, called density estimation, consists in the creation of a density function from the observed data. Compared to histograms, which also are density estimations, kernels are smooth and independent from the choice of intervals, such as the case of the histogram, which are vulnerable to noise and miss details in regions where data concentrate (Salgado-Ugarte and Pérez-Hernández 2003:133).

The kernel estimator, with kernel K is defined by (Silverman 1986:9):

$$\hat{f}(x) = \frac{1}{nh}\sum_{i=1}^{n} K(\frac{x - X_i}{h})$$

where:

h is the smoothing parameter or bandwidth,

K is the kernel function.

Although there are several types of kernel functions, for the present research the Epanechnikov kernel function was used since is the most efficient in minimizing the mean integrated squared error (StataCorp 2017:1279). As mentioned in the literature, the choice of the bandwidth is more important than the choice of the kernel function (Cameron and Trivedi 2005:298). Because of this, the chosen bandwidth is determined by (StataCorp 2017:1279):

$$m = min\ (\sqrt{variance_x}, \frac{interquantile\ range_x}{1.349})$$

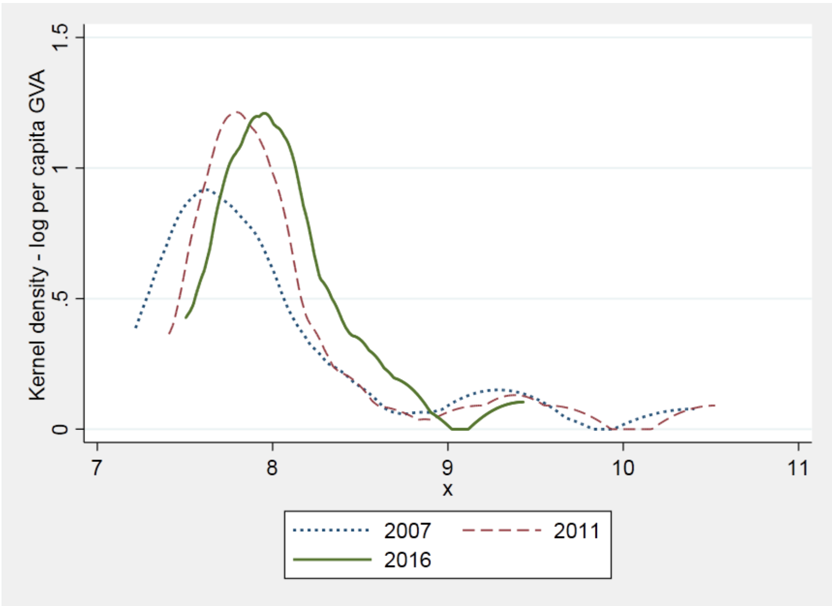
$$h = \frac{0.9m}{n^{1/5}}$$

where x is the variable of interest and n is the number of observations.

5.2.1 Estimation results for per capita GVA

Figure 5.6 shows the kernel densities of the distribution of the per capita GVA in three different stages. The initial stage, in 2007, shows high dispersion of the regional GVA, along with the presence of three peaks in the distribution. In 2011, the entire distribution shifts to the right indicating an overall increase in the GVA for all the provinces. However, the higher shape of the distribution indicates that there is a larger number of provinces that have relocated to a lower stratum of the income distribution. In 2016 the situation improves: the entire distribution keeps moving to the right indicating an overall growth. Also, the distribution becomes more uniform and it is possible to see the formation of two groups of provinces: a small one composed with provinces with high GVA and the second, with medium and low GVA.

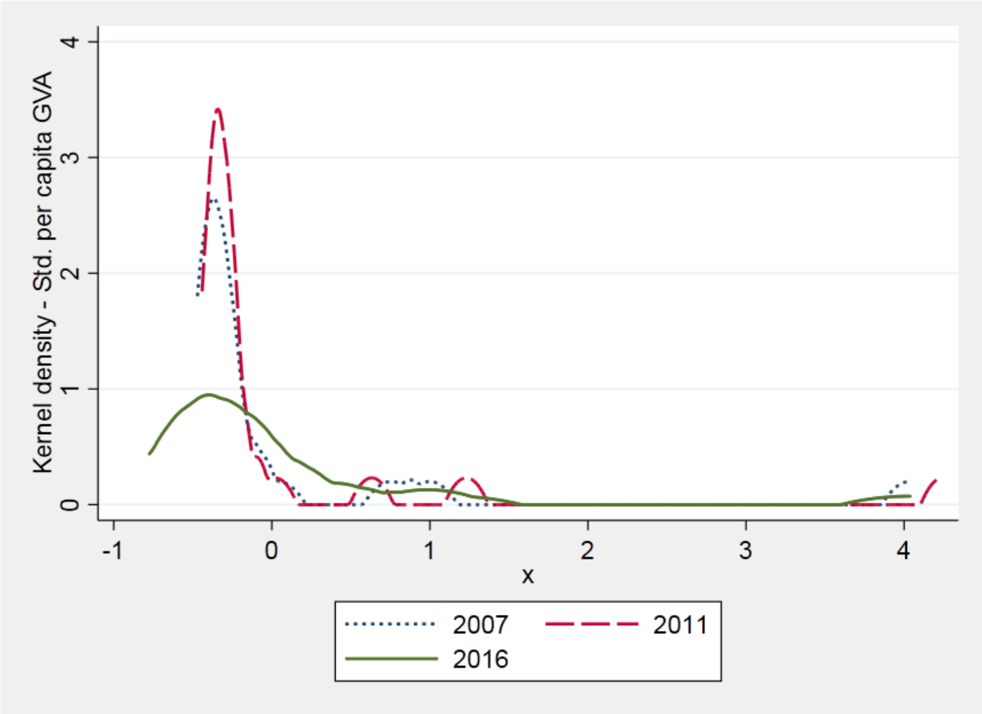
Figure 5.6 Kernel densities - per capita GVA



Source: Author's elaboration

This situation can also be confirmed by analysing the standardized values of the per capita GVA (Figure 5.7). It is possible to see that from 2007 to 2016, the distribution has become more uniform towards the mean. There is a reduction on the number of outlying provinces, which represented the peaks besides the mean value in the previous years.

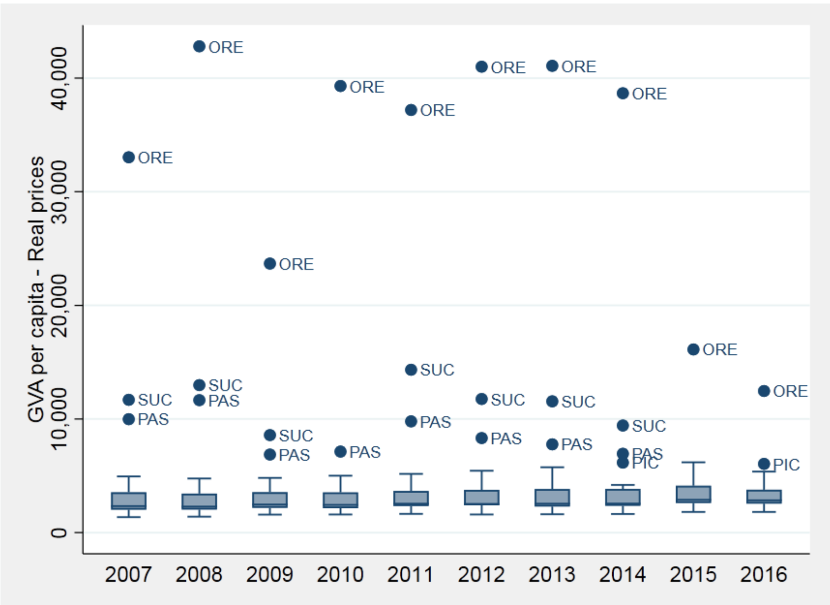
Figure 5.7 Kernel densities – standardized per capita GVA



Source: Author's elaboration

By using a boxplot, it is possible to have a more detailed view of the dynamics of the GVA distribution. Figure 5.8 shows that along the period of analysis, the mean value of the distribution has increased constantly. Also, the influence of the province of Orellana, which is the richest one due to the presence of the oil activities, tends to broaden the shape of the distribution and thus, the levels of inequality among provinces.

Figure 5.8 Box plot - per capita GVA



Source: Author's elaboration

In the same sense, Table 5.1 presents the differences among different percentiles of the GVA distribution. It is possible to confirm the reduction in the difference between the richest and poorest provinces because in 2016, the decile composed by the richest provinces has a per capita GVA 2.7 times higher than the poorest one. In contrast, in 2007, the ratio was 6.3 times the per capita GVA of the poorest decile.

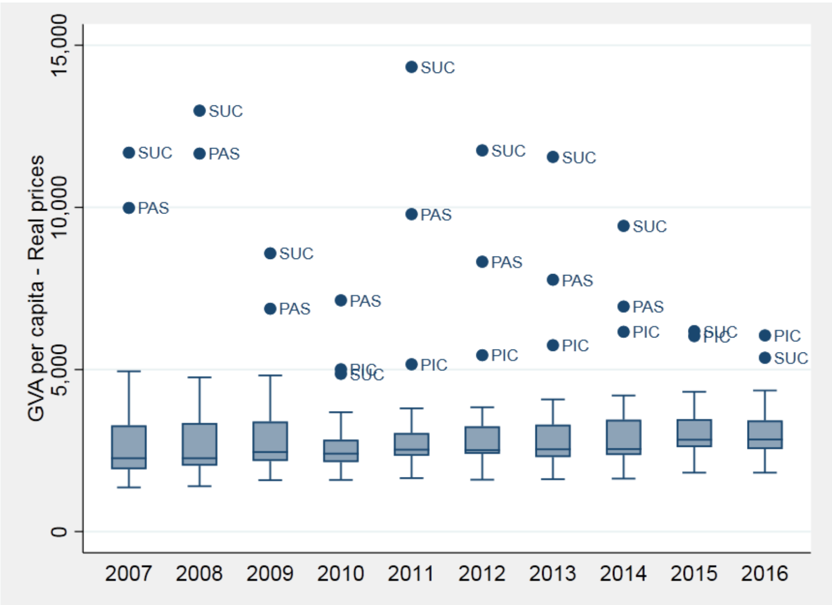
Table 5.1 Percentile ratios for per capita GVA

Year	p90/p10	p90/p50	p10/p50	p75/p25
2007	6.343	4.277	0.674	1.765
2016	2.653	1.885	0.711	1.482

Source: Author's elaboration

By excluding the province of Orellana, it is possible to see that the income distribution shrinks from 2010. However, from this point, the distribution shows an expanding behaviour until 2016 (Figure 5.9). Also, the provinces of Sucumbíos, Pastaza and Pichincha conform a group of rich provinces whose performance influence the shape of the distribution.

Figure 5.9 Box plot - per capita GVA (excl. Orellana)



Source: Author's elaboration

The reduction in the dispersion of the per capita GVA is also visible when comparing the percentile ratios (Table 5.2). From this, it is possible to see that the influence of Orellana increased the gap between rich and poor provinces from 4.8 to 6.3 times in 2007.

Table 5.2 Percentile ratios for per capita GVA (excl. Orellana)

Year	p90/p10	p90/p50	p10/p50	p75/p25
2007	4.804	3.298	0.687	1.702
2016	2.153	1.532	0.712	1.347

Source: Author's elaboration

5.2.2 Estimation results for non-oil per capita GVA

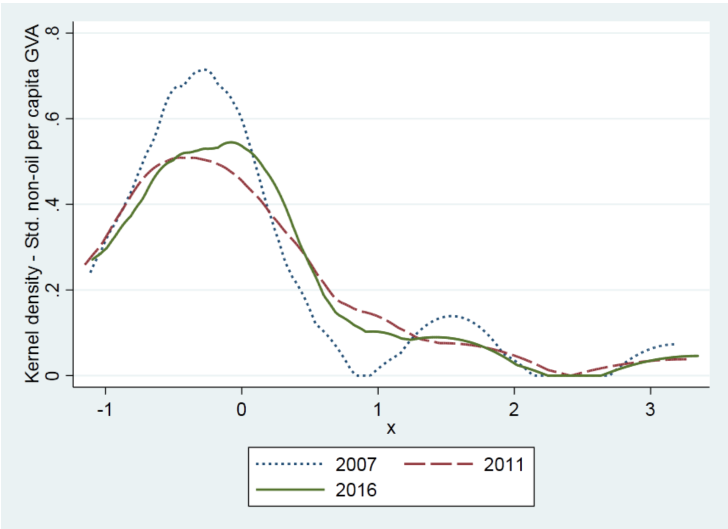
In terms of the non-oil per capita GVA, Figure 5.10 presents the evolution of the kernel densities in the period of analysis. In general terms, the distributions are more homogenous than the previous case, despite the sigma convergence indicated a constant trend in the dispersion of this variable. It is important to say that both in 2011 and 2016, the concentration of provinces among income groups has disappeared to favour a distribution with a few outliers.

Figure 5.10 Kernel densities - Non-oil per capita GVA

Source: Author's elaboration

By standardizing the non-oil per capita GVA, it is possible to see the reduction of the dispersion of the distribution. In 2007, one province, Pichincha, had the highest GVA, followed by Guayas and Azuay that represented the second peak in the distribution. In the following years, Pichincha appears at the only outlier that shapes the income distribution. Also, the middle peak has been replaced by a wider distribution around the mean value.

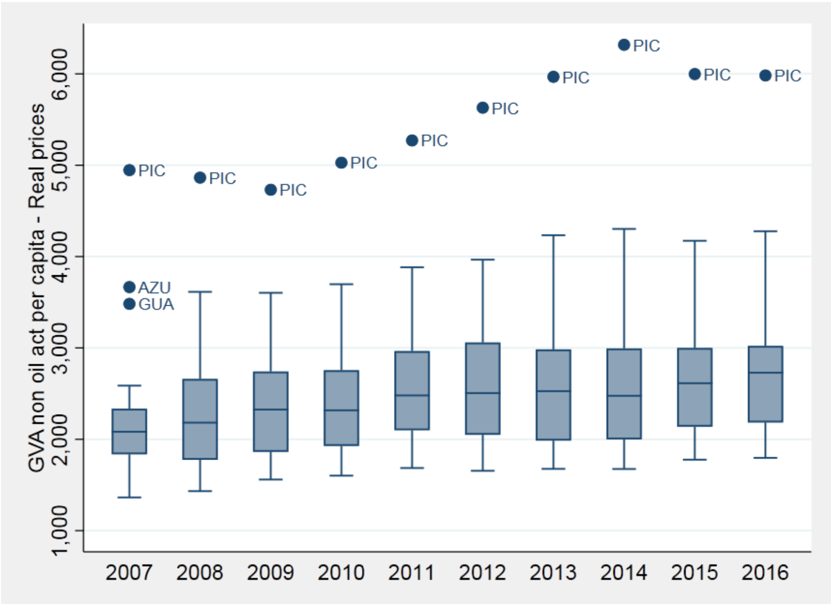
Figure 5.11 Kernel densities – Standardized non-oil per capita GVA



Source: Author's elaboration

This trend can be analysed with more detail on Figure 5.12. The plot indicates that, in general terms, the mean GVA of the provinces has increased along the period. Also, the province of Pichincha has become the richest province and it shapes the dispersion of the distribution, in contrast with the provinces of Guayas and Azuay that do not manged to accumulate the same levels of non-oil GVA.

Figure 5.12 Box plot - non-oil per capita GVA



Source: Author's elaboration

In terms of the gap between rich and poor provinces, Table 5.3 shows that the ratio between the richest decile and the poorest one has reduced in the period of analysis and it remains at the same level that the one calculated using the total GVA per capita.

Table 5.3 Percentile ratios for non-oil per capita GVA

Year	p90/p10	p90/p50	p10/p50	p75/p25
2007	2.511	1.42	0.565	1.672
2016	2.377	1.796	0.756	1.525

Source: Author's elaboration

In brief, the presence of the revenues of the oil-related activities contributes to increase the dispersion of the per capita GVA among provinces. Although there is a reduction in the dispersion during the period of analysis, it is important to remark the change in the shape of the distribution. For both GVA, the distribution has shifted from a multimodal shape to a one in which two groups are conformed: a small group of rich provinces followed by a large group of non-wealth ones.

Chapter 6 Conclusions

The present research paper adds to the literature the use of a parametric and a non-parametric approach to analyse the relationship between economic growth and regional inequality in Ecuador. From the findings of each chapter, the following conclusions are drawn.

Regional inequality, measured through Gini and Theil indices, has decreased between 2007 and 2016. However, by discounting the influence of the oil activities, inequality experienced a low but constant trend in the period of analysis. Compared to the results found for regions of the European Union (Doran and Jordan 2013), Ecuador presents a higher degree of inequality measured by the Theil index. The main factor that has driven the changes in the levels of inequality is the economic cycle of the Ecuadorean economy, since negative variations in the growth rate are associated with reductions in the inequality among regions. This result reinforces the idea that economic convergence occurs in periods where the growth rate decays, while divergence raises with economic growth (as cited in Rodríguez-Oreggia 2005:207).

The convergence analysis shed lights on the relationship between the initial conditions of an economy, its potential to reach the wealth levels of a rich one through the growth rate, and the factors associated with the variations of this rate. By establishing a relationship between the initial conditions of a province, measured by the per capita GVA, and the average growth rate of the period, it was possible to determine that poor provinces are growing faster than the rich ones. However, since their growth rates are still low, the speed of convergence will not allow them to catch up in the short-run. By controlling the previous relationship through the inclusion of additional factors that could explain economic growth, the hypothesis of convergence holds for the per capita GVA, while for the non-oil per capita GVA the results are not conclusive. With this finding, it is possible to reject the hypothesis that beta convergence does not necessarily lead to a reduction in the dispersion of the GVA of every province, measured as sigma convergence (Gluschenko 2012:3)

In the case of the determinants of growth of the per capita GVA, the total income of the province is the most important determinant of the economic growth at a regional level. On the other side, provinces which are highly dependent on its oil sector register lower average growth rates. For the non-oil GVA, the factor that is negatively associated with the growth rates is the area of the province. On the other side, the process of urbanization, and the increase of the share of the manufacture in the economic structure of the provinces is associated with higher growth rates in non-oil per capita GVA. Also, the human capital variable showed low but significant results, confirming the findings in the literature. Finally, the institutional variables did not show an effect over the growth rate, which could be explained by the fact that these variables do not exert an effect on the growth rates in the short-run. In methodological terms, the possible presence of spatial autocorrelation was discarded due to the results of the Moran's-I statistic and the inclusion of the influence from the neighbouring provinces in the regressions. Moreover, this variable was not an important determinant of economic growth.

In the analysis of the dynamic of the income distribution, the use of plots is an ideal complement to the traditional convergence approach. It allows to determine if inequality among regions is reducing, indistinctly from the growth rates of the poor and rich ones. In the Ecuadorian case, the results indicate a process of convergence and a reduction of regional inequalities, measured both by the dispersion of the logarithm of the per capita income and the behaviour of the distribution of the gross value-added. Also, during the period of analysis, the difference among the richest and the poorest deciles decreased.

From these results, the main policy implication that arise is the dependence of the regional inequality on the growth rate of the economy. Although several policies were adopted to promote a diversification in the Ecuadorian exports, the dependence of the country on the oil revenues makes it difficult to establish a long-term process of structural change. Also, the historical patterns have determined the creation of three economic centres which, in a process of economic growth, could diverge from the rest of the provinces increasing regional inequality. In this sense, it is necessary to promote the relocation and the diversification of economic activities because it could boost the growth rates of the region (as cited in Rosenthal and Strange 2004:2134). Finally, in terms of the GVA per capita, provinces that have a higher value of this amount does not necessarily have an equal level of living standards in its population. An example of this is Orellana, the province that appears as the richest in the analysis but in terms of unsatisfied basic needs, 41% of its population is categorized as poor, which is superior to the national average by nine points (SIISE 2018).

In terms of the limitations for the present research, the main one is the lack of consistent regional information to allow the analysis of the patterns of convergence and regional inequality in the long-run. Because of this, the analysis of regional inequality in Ecuador have solely relied on the analysis of absolute convergence.

A possible critique for the present research is the use of random-effects regressions instead of fixed-effects, when analysing convergence with the panel data. Although the literature recommends the use of fixed-effects in convergence analysis (Islam 2005), the aim of the present document was to analyse the influence of several factors in the average growth rate. In this sense, a fixed-effects specification would have discarded the geographical or the ethnical factors because they do not vary over time. Also, fixed effects estimator ignores the variation between units, and the reduction of bias is substituted by higher standard errors (Durlauf et al. 2005:630). Nevertheless, to give more consistency to the results, regional and time fixed effects were added to the panel specifications to control for any possible source of bias (Durlauf et al. 2005:631).

Another limitation of the analysis lies on the characteristics of some of the determinants used to determine the growth rate. Since some of the variables are stable over time, they can hardly influence the growth rates in the short-run (Durlauf et al. 2005:631). Because of this, in the short-run, some determinants suggested by the literature might appear not significant when in the long-run, the could influence the growth rates of a region. To address this limitation, the availability of long time series data at a regional level is necessary. Still, in the Ecuadorian case, this information is scarce.

Following the conclusions, some topics are pointed out to suggest further research in the field of economic growth and regional inequality.

First, to address the problem of the lack of economic data at a regional level, some authors rely on the use of satellite data to obtain estimates of information that is not available from official statistical offices (Jean et al. 2016, Donaldson and Storeygard 2016). Yet, for the present research, the use of satellite data to account for developments in terms of infrastructure or economic activity was discarded due to the collection and processing costs of satellite images at a regional scale.

Second, despite that the results of this document do not show an important bias caused by spatial autocorrelation, further research can be done by incorporating the spatial dependence of the economic units in the regression analysis. In this paper, this problematic was addressed by using one variable that captured the growth of neighbouring regions and by the analysis of spatial autocorrelation indices. However, more sophisticated econometric techniques could be applied to capture this phenomenon.

Finally, another line of research can be devoted to the use of non-parametric techniques in the convergence analysis. In the present document, ordinary and generalized least squares were the tools applied to determine conditional convergence. However, these models impose a linear relationship among the variables, omitting any other kind of functional forms.

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